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CONTENTS FOR DECEMBER 1941

Vol. 22, No. 12

EDITORIALS 420

SEED DRIER USES INFRARED ELECTRIC LAMPS 421
By John E. Nicholas and H. B. Musser

BIG WATERS ON LITTLE STREAMS 424
By Albert S. Fry

CASE STUDIES IN LOW-COST HOUSING 427
By Deane G. Carter

THE DESIGN OF PLOT EXPERIMENTS FOR MEASUREMENT OF RUN-OFF AND EROSION 429
By Dr. A. E. Brandt

HOW MUCH RENT CAN A COW PAY? 433
By M. Glen Kirkpatrick

A POULTRY VENTILATION PROBLEM 435
By Dr. M. W. Emmel

ECONOMIC POSSIBILITIES OF FARM MECHANIZATION 437
By Dr. R. B. Corbett

ELECTRIC LIGHT IN INSECT AND BACTERIA CONTROL 439

APPLYING FERTILIZER IN LIQUID FORM 440
By Dr. Victor A. Tiedjens

ANOTHER AGRICULTURAL ENGINEERING MILESTONE 441
By Walter B. Jones

NEWS 444

AGRICULTURAL ENGINEERING DIGEST 448

EDITORIALS

Mechanization Needed to Abolish Human Drudgery

In a most interesting and entertaining talk before a meeting of the North Atlantic Section of the American Society of Agricultural Engineers held at Jackson's Mill, W. Va., in October, Mr. Ben Hibbs, editor of "Country Gentleman," told the assembled agricultural engineers what he thought to be their biggest job, namely, "to abolish human drudgery from agriculture" — of course mainly through mechanization and other engineering means. And it is with the purpose of constantly reminding ourselves of what our profession recognizes as perhaps the most basic challenge always confronting agricultural engineers, that we quote here the particular portion of Mr. Hibb's talk that referred specifically to the unfinished, even the never-ending task before us, and that gave, too, an example of how a machine, the product of engineering skill, helped to remake agriculture in an area where it had before seemed almost hopeless.—EDITOR.

BECAUSE I have no scientific reputation to guard, I can tell you engineers what I think is your biggest job in the years ahead.

I think your job is to abolish human drudgery from agriculture.

You have made a magnificent start, but the task is far from finished. Go into a region where most of the farm work is handled by machinery, such as the wheat country. *Look at the people.* Go into another region where, because you engineers have not yet got your teeth into the job, the farmer must bend his back over the hoe or the cutting knife from dawn to dark. Again, *look at the people.* Note how much longer men stay young and upstanding and vigorous in the region where crops are made by machinery.

But, someone may say, you can't completely mechanize such crops as tobacco, many of the vegetables and fruits, and dozens of other branches of farming. It just isn't in the wood.

I don't believe it. I've seen too many miracles happen; and, moreover, I have a tremendous respect for and belief in the capacity of the engineering profession.

Furthermore, I am confident that you agricultural engineers have too much hard common sense to be turned away from this biggest task of all by the cries of certain people that we must halt mechanization to save the jobs of men and women and children who now bend their backs to the soil. Yours must be the long-time view, the greater objective — the end of drudgery. Only thus does man progress — by driving forward ceaselessly toward a better life. Some wreckage is left beside the line of march, to be sure, and there are always adjustments to be made. . . . . The tragic fact that some people have been "tractored off" the land must not delay our march toward the end of human drudgery.

After all, none of us is smart enough even to estimate the good that may come from a new machine. I can't help thinking of an unexpected contribution which the combine has made in my home country, the great wheat lands of the western prairies. I wonder how many of you know that the combine literally created a new crop — a crop which right now is helping save a region which a few years ago we called the "dust bowl".

Farmers of the southwestern high plains never had a good feed crop until just recently. But they have one now, and it is creating a new, diversified, sounder agriculture in the winter wheat belt. Corn has been pretty hopeless on those semiarid, wind-swept plains; the various sorghums, kaffirs, and milos were grown to some extent but never did well. They were too vulnerable to wind and sun and drought.

Then the wheat combine came along, and wheat farmers began to ask for a variety of sorghum feed crop which they could harvest with this wonderful new labor-saving machine. A plant breeder at Woodward, Oklahoma, and another at Hays, Kansas, set to work, and in due time they emerged with a short, stout variety of milo which grows about thirty inches tall and has a straight, strong neck that holds its heavy head so completely erect that it can be harvested with a wheat combine.

But in creating a crop which could be handled with the new wheat machinery, these patient plant breeders had done something even more spectacular and important. They had produced a milo that was short enough and tough enough to stand the battering prairie winds; a crop, moreover, that matures easily before frost, which often strikes early on the high plains. It will come through ten inches of rainfall; it is good cattle feed; and its tough stubble remains on the fields during the winter and early spring blowing season — holding the earth in place.

"Combine milo," as the farmers call it, is helping remake agricultural practices in an area twice as large as all of New England. It is helping lay the dust — we hope forever. It came into being because of a machine which was invented for another purpose entirely.

Again I say, the march of mechanization must not be delayed.

Ag Engineers Are Awake

LETHARGY in individuals, groups, or nations is one of the great evils that beset mankind, and unless dissipated by a strong sense of alertness to lurking dangers and by an earnest desire for constructive activity and progress, it may lead its victims into difficult situations, to say the least. The most recent of momentous events on the international scene, for example, is serving as a terrific jolt to national lethargy, and provides a striking example of how essential it is to be constantly on the alert and prepared to explore new paths and to overcome all obstacles toward progress and the successful accomplishment of righteous objectives.

During the past year — perhaps more than at any time heretofore — evidence has been accumulating to the effect that agricultural engineers are alert to the need for greater progress, for improving their situation as a professional group. This has been particularly apparent in the meetings of the American Society of Agricultural Engineers. Many speakers on meeting programs have emphasized this need, have pointed out weak links in the chain and how they might be strengthened. Meetings of the Council and of committees have been the scene of lively discussions of possible ways and means to bring about improved performance in the agricultural engineering profession. The many confabs of small groups that are an important and vitalizing adjunct of every meeting, produce the spark of stern resolve so necessary in any effort to do a better job *for* agricultural engineers and *as* agricultural engineers. Indeed, the agricultural engineers who attend the meetings of the national society which represents them, furnish abundant evidence that they are "not asleep at the switch." They are awake!

The research group, for example, has stepped out at a sprightly pace to focus attention on the great need of research as a tremendously important foundation stone in the agricultural engineering structure. This particular activity, as well as other evidences of alertness on the part of our group as a whole, is encouraging and reassuring. Let's keep awake, and active, and pushing our job nearer and nearer to completion — *and* on a plane of excellence that we can look back upon with the utmost satisfaction when our role has been played.

AGRICULTURAL ENGINEERING

VOL. 22 DECEMBER 1941 NO. 12

Seed Drier Uses Infrared Electric Lamps

By John E. Nicholas and H. B. Musser

MEMBER A.S.A.E.

RED FESCUE seed can be successfully produced in Pennsylvania, and it can be satisfactorily harvested by means of the combine. Because of the excess moisture in the combined seed at harvest, it was necessary to develop a convenient and satisfactory method of seed drying and conditioning that would prevent rapid loss of viability by the seed under ordinary storage conditions.

The work of Kearns and Toole[1] shows that there are appreciable losses in viability of fescue seed when stored at temperatures higher than 68 F (degrees Fahrenheit), if the moisture content of the seed is in excess of 10 per cent. On this basis, drying equipment was required to reduce the moisture content of the seed below the critical 10 per cent quickly, conveniently, and efficiently, without injury to germination. The possibility of doing this electrically was believed to offer a satisfactory solution to the problem.

Since this was a new conception in methods of drying seed, no experimental data were available as to the intensity of heat, the range in temperature which seed could withstand, and the rate at which seed would lose moisture. Consequently, it seemed desirable to secure preliminary data on these factors under static conditions. Temperature distributions were first obtained at various distances from the center of a 250-w, infrared, clear-bulb drying lamp with a golden reflector, as shown in Fig. 1. Temperatures were recorded by thermometers with mercury wells located on concentric radii as indicated in the figure. Data were recorded for two different conditions, namely, when the lamp and reflector were 3 in above the heated surface (adjustment A), giving a high intensity localized heated area, and when the lamp itself was lowered to a height of only 2¼ in above the surface adjustment, while the reflector was raised to 5¾ in, thus spreading the radiant energy over a larger area. Results of the measurements for the A adjustment are shown by the solid curve in Fig. 1, and for the B adjustment by the broken curve. It is recognized that this represents data under static conditions and does not measure the true value of the radiant energy received at specified locations. It served, however, as a rough guide in making lamp and reflector adjustments for preliminary seed drying trials, and gave a hint as to the limits of the variable factors involved.

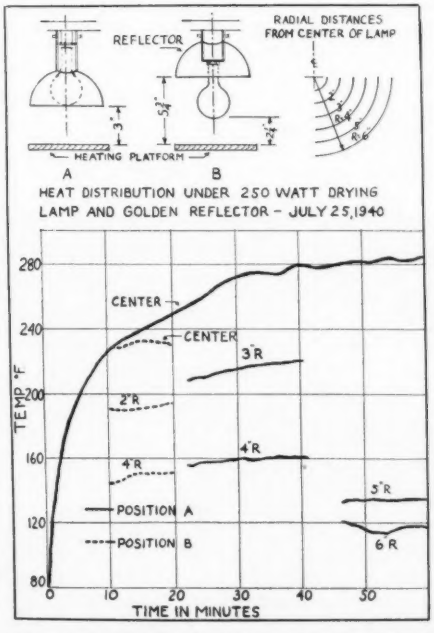


Fig. 1 Time-temperature relation under two different settings and arrangements of a 250-w infrared lamp, obtained on wood (plywood) surface measured with thermocouples at successive radially increasing distances

Preliminary seed drying trials were also made under static conditions using a 3¼-in height adjustment of lamp and reflector above the platform (adjustment A, Fig. 1). Two samples of mature red fescue seed were harvested from the field under extremes in moisture conditions.

Sample 247 was taken under cool, dry conditions with low air humidity. Sample 252 was taken about one hour after a heavy shower when the air humidity was high and both soil and plants were quite moist. Representative portions of each sample were subjected to five heating periods ranging from 1 to 5 min under the infrared lamp.

In all cases a layer of seed approximately ¼ in deep was used in the tests. Drying-oven moisture determinations were made in duplicate on each original lot of seed and on samples dried for the various periods. Germination tests also were made on all heating-time series and the original samples in quadruplicates of 50 seeds each, at alternating temperatures of 50 to 86 F. Moisture loss and germination data on all series are presented in Table 1.

These data indicated that it was practicable to remove sufficient moisture from red fescue seed, even with an extremely high original moisture content by the use of infrared heat. The results also showed that germination was appreciably injured at the longer heating times at the temperatures indicated with no agitation of the seed during the heating period.

In order to secure preliminary information on heating temperatures that could be used safely, a series of drying oven tests of the 12.4 per cent moisture seed was made at temperatures of approximately 200 F for 10 drying periods of from 3 to 30 min. Table 2 gives the total percentages of moisture and of moisture lost, together with percentages of germination for the samples dried for various periods.

Authorized for publication on November 17, 1941, as paper No. 1060 in the Journal Series of the Pennsylvania Agricultural Experiment Station. Authors: Professor of agricultural engineering and professor of agronomy, respectively, Pennsylvania State College.

EDITOR'S NOTE: This article is a preliminary report on a continuous infrared electric seed drier and conditioner for red fescue and other seed, and was released for first publication in AGRICULTURAL ENGINEERING.

[1] Vivian Kearns and E. H. Toole, "Relation of Temperature and Moisture Content of Longevity of Chewings Fescue Seed". Technical Bulletin No. 670, April 1939, U. S. Department of Agriculture.

The data in Table 2 show that there was no appreciable injury to germination of seed of this quality at the temperatures and for the drying times tested. Since it was hoped that adequate drying could be secured with infrared

TABLE 1. COMPARATIVE MOISTURE AND GERMINATION OF ORIGINAL SEED AND DRIED SERIES OF RED FESCUE SEED HEATED FOR VARIOUS PERIODS UNDER INFRARED LAMP AT TEMPERATURE OF 235 F WITHOUT AGITATION

	Sample No. 247				Sample No. 252			
Heating time	H_2O, %	H_2O lost, %	Germ., %	Germ. loss, %	H_2O, %	H_2O lost, %	Germ., %	Germ. loss, %
None (original seed)	12.2		99		26.4		73.0	
Dried 1 min	10.1	2.1	98	1	21.8	4.6	60.0	13.0
Dried 2 min	9.8	3 4	98	1	18.8	7.6	28.0	45.0
Dried 3 min	7.4	4.8	88	11	16.2	10.2	10.0	63.0
Dried 4 min	6.3	5.9	91	8	13.3	13.1	1.0	72.0
Dried 5 min	5.4	6.8	73	26	9.0	17.4	.0	Total

heat at temperatures of 200 F or less by seed agitation and proper lamp adjustments, no further preliminary drying-oven tests were made at this time. It is recognized that additional tests will be necessary to determine maximum temperatures which can be used with seed of different species and moisture content.

TABLE 2. MOISTURE AND GERMINATION TESTS OF RED FESCUE SEED OVEN DRIED AT 200 F FOR VARIOUS PERIODS OF TIME

Heating time, min	Per cent moisture	Per cent moisture lost	Per cent germination
None	12.45		86.5
3	11.24	1.21	87.0
6	10.40	2.05	89.5
9	9.46	2.99	83.5
12	8.24	4.21	90.0
15	7.41	5.04	85.5
18	6.42	6.03	88.0
21	6.03	6.42	84.5
24	5.41	7.04	85.0
27	5.15	7.30	90.0
30	4.57	7.88	82.5

On the basis of the above preliminary data an experimental continuous process drier was constructed for further testing work.

In the design of the machine three factors were considered important, namely, (1) flexibility to accommodate all kinds of seeds and their varying degrees of moisture, (2) convenience and ease of operation, and (3) economy of operation and adaptability to farm practice for seed and grain drying.

The drier consists essentially of a simple rigid frame or structure which supports (1) the two end drums that carry the variable speed conveyor on which the seed dries, (2) the lamp frame located above the belt conveyor which carries a bank of infrared lamps which furnish the radiant energy, (3) the supply and receiving hoppers, and (4) the platform which carries the variable speed reducer and the fractional ¼-hp electric motor that drives the conveyor.

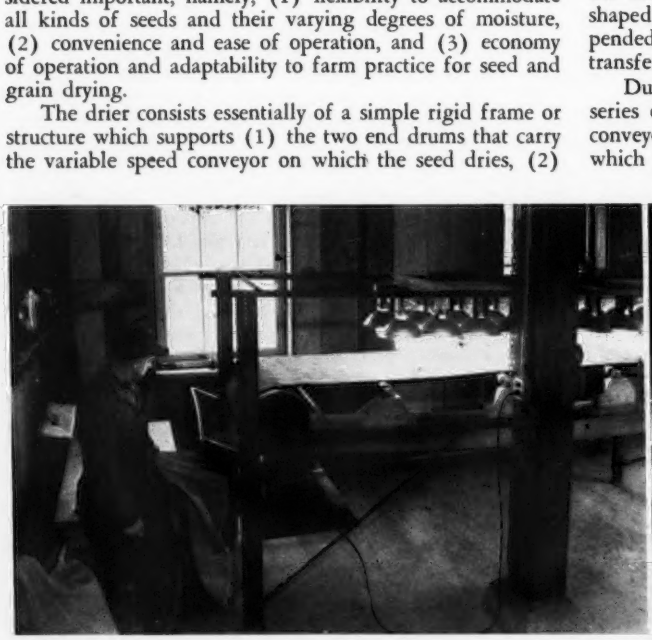
The end drums are 15 in in diameter and are spaced on 20-ft centers, so located on the main structure that the top of the conveyor is at the convenient height of 50 in, but adjustable to accommodate other environments. The conveyor is a 24-in, four-ply rubberized belt driven by a ¼-hp motor. Belt speeds can be varied for seven different rates by the use of various size step-cone pulleys. Heat energy is provided by 250-w infrared lamps arranged on a frame above the belt in two rows of 20 lamps each, giving a connected load of 10 kw.

The conveyor speed ranges from less than 4 to nearly 18 min, which is the time the seed is exposed to the lamps in passing from the supply to the receiving hoppers. The platform carrying the variable-speed drive is located directly below the receiving hopper shown in Fig. 2. The conveyor is capable of withstanding a temperature of 300 F. The loaded or tight side of the conveyor is supported by a series of rollers so spaced that there is practically no deflection from the horizontal, even at full loading.

The infrared lamps are individually adjustable for different heights from the conveyor surface and the entire frame can be raised or lowered or sloped in either direction. This flexibility of adjustment to lamps and lamp frame makes it possible to obtain more uniform radiant heat energy across and over the length of the conveyor during the drying operation.

When the seed drier and conditioner is in actual seed drying operation, the seed is fed onto the belt from the supply hopper shown in Fig. 3. It has a capacity of approximately 4 bu. The flow of seed is regulated by a control gate operated by a rack and pinion, which insures a constant supply and regulates the thickness of the layer of seed on the belt for any size grain. The dried seed discharges from the conveyor at the delivery end directly into a funnel-shaped receiving hopper from which a bag may be suspended for direct bagging as shown in Fig. 2. It is then transferred to the cleaning equipment.

During drying, agitation of the seed is obtained by a series of plow racks spaced at 2-foot intervals above the conveyor belt. Each rack carries multiple plow fingers which turn the seed as it passes. Every other plow rack



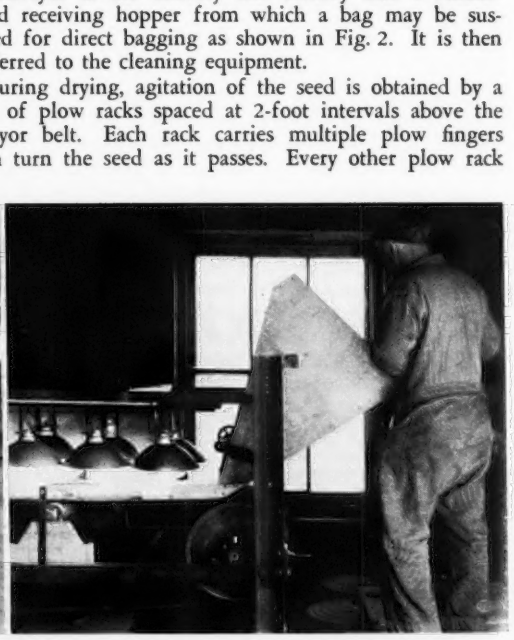


Fig. 2 (Left) The delivery end of the infrared seed drier and the funnel-shaped receiving hopper from which a bag is suspended to collect the dried seed • Fig. 3 (Right) This view shows the method of feeding the seed onto the conveyor belt from the supply hopper located on one end of the main structure directly above the conveyor pulley or drum of the drier

reverses the direction of agitation, thus assuring more uniform surface exposure of the seed during the drying interval.

The drier capacity depends upon the speed of the conveyor belt, the quantity of radiant heat energy, the depth of the seed layer on the conveyor, and the type and moisture content of the seed processed. With the speed of the conveyor set at 4 min and 50 sec, the drier capacity in pounds per hour using three species of grasses and legumes with an approximately 1/4-in thick seed layer is given in Table 3.

TABLE 3. DRIER CAPACITY IN POUNDS PER HOUR FOR VARIOUS SPECIES OF GRASSES AND LEGUMES AT A 4 MIN 50 SEC CONVEYOR SPEED

Species	Pounds seed per hour
Red fescue	160
Red clover	248
Soybeans	369

To date two series of drying tests have been made with red fescue seed. The first series was made on October 3, 1940, at four different conveyor belt speeds: 2 min 55 sec, 4 min 50 sec, 8 min 40 sec, and 17 min 55 sec with a 40-unit bank of lamps. The second series was made on May 15, 1941, at three speeds: 4 min 50 sec, 7 min 19 sec, and 11 min 42 sec with a 60-unit bank.

In all cases the conveyor belt was preheated for a few minutes before initial test runs were made. The belt temperatures at the end of the preheating periods averaged approximatly 180 F. Standard thermometers placed on the surface of the seed were used in these preliminary tests to record seed temperatures during the drying process. Readings were made at intervals along the belt, and it was found that the maximum temperature was attained by the seed as it passed under the last lamp in the bank. This temperature, therefore, was recorded as the drying temperature of an individual test run.

It is recognized that the temperatures so recorded do not accurately record the true heat conditions and amounts of radiant energy received. Since no information is available on the depth of infrared penetration into the seeds, the exact amount of energy as recorded by thermometer during the test would be only an approximation. In subsequent tests a vacuum type of thermocouple will be used so that the exact amount of energy received can be determined.

Approximately 15 lb of red fescue seed from the same bulk lot were used for each test run. Maximum temperatures were recorded as has been indicated for each heating time tested. The heating-time records cover the periods during which the seed was directly under the heating units.

In the first series of tests all the seed from an individual run was composited and sampled as a unit for moisture and germination tests. In the second series of tests composite samples were taken in the same manner. In addition, samples from the second series were taken at the time of the 11-min 42-sec run, from the light and dark bands on the belt. The band of greatest light concentration directly under an individual tier of lamps was designated as the "light band", while the band of less light concentration between lamp tiers was designated as the "dark band".

In all cases duplicate samples of approximately one pint of seed were placed in pressure-top, air-tight containers for moisture and germination tests. Duplicate tests were made on each sample, thus providing quadruplicate determinations for the individual test runs. Moisture determinations were made in a standard drying oven at 220 F to constant weights. Germination tests were made on moist blotters in petri dishes held in cabinets at temperatures alternating each 24 hr from 68 to 86 F for 15 days.

The complete data for the two series of tests are shown in Tables 4 and 5. As above noted, moisture and germination figures are averages of quadruplicate determinations. Moisture data are given as the total percentages in the dried seed and the percentages lost for each heating period.

TABLE 4. SERIES 1 DRYING TESTS WITH 40-LAMP BANK, OCTOBER 3, 1940; MAXIMUM TEMPERATURES, TOTAL MOISTURE, MOISTURE PER CENT LOST, AND TOTAL GERMINATION OF RED FESCUE SEED TREATED FOR VARIOUS PERIODS IN THE INFRARED SEED DRIER AS COMPARED WITH UNDRIED SEED

Drying time	Max. temp, F	Total moisture, %	Moisture lost, %	Total germination
None		12.4		88.0
2 min 55 sec	149	10.8	1.6	89.0
4 min 50 sec	171	9.5	2.9	91.5
8 min 40 sec	168	9.0	3.4	88.0
17 min 55 sec	197	7.1	5.3	86.5

The data show that under the conditions of this test it was possible to reduce the moisture content of the seed to a safe storage figure (less than 10 per cent moisture) with a 4 min and 50 sec heat treatment. In the case of the 40-lamp bank test the moisture reduction was 2.9 per cent at this heating time, and for the 60-lamp bank test the moisture loss was 3.6 per cent.

TABLE 5. SERIES 2 DRYING TESTS WITH 60-LAMP BANK, MAY 15, 1941; MAXIMUM TEMPERATURES, TOTAL MOISTURE, MOISTURE PER CENT LOST, AND TOTAL GERMINATION OF RED FESCUE SEED TREATED FOR VARIOUS PERIODS IN THE INFRARED SEED DRIER AS COMPARED WITH UNDRIED SEED

Drying time	Location on belt	Max. temp., F	Total moisture, %	Moisture lost, %	Total germination
None			12.3		82.5
4 min 50 sec	Composite	185	8.7	3.6	80.0
7 min 10 sec	Composite	200	6.9	5.4	81.0
11 min 42 sec	Composite	210	6.5	5.8	80.5
11 min 42 sec	Dark band	184	7.6	4.7	80.0
11 min 42 sec	Light band	210	5.7	6.6	78.0

Germination tests of the treated seed showed that there was no appreciable injury to viability, as variations in readings were well within error limits.

The preliminary results with the infrared seed drier and conditioner indicate that it has definite possibilities for the rapid drying of seed without injury to germination. The following types of seed were tested: red fescue, rye grass, tall fescue, brome grass, red clover, barley, soybeans, and wheat.

The present tendency toward combine harvesting of grains and grasses and legume seed makes the rapid and economic drying of seed as it comes from the field imperative and necessary if the products are to be safely stored. This drier offers the desired answer to this new problem.

Its usefulness is not necessarily limited to drying of seed. Fruit or grass could be dried. It has been suggested that "awakening" of seed potatoes which have been stored under conditions prevalent in the northern states, such as Maine, would shorten the period between planting and sprouting.

While the capacity of the particular equipment used in the tests is limited as indicated, it would seem to be entirely practicable to get capacities to meet individual requirements by adjustment of lamp numbers and belt sizes.

So far as is known, this machine is the first infrared continuous electric seed drier and conditioner. The development of this new equipment was primarily made to meet the definite need for seed conditioning that is incidental to the commercial production of red fescue and other field seeds which is just beginning to be of practical importance to Pennsylvania. *(Continued on page 426)*

Big Waters on Little Streams

By Albert S. Fry
MEMBER A.S.A.E.

ORDINARILY floods on streams draining small watersheds may cause considerable damage but are not likely to ruin completely the lands along the streams. However, in the mountainous valleys of the Appalachians in western North Carolina and eastern Tennessee, floods which occur over these smaller stream watersheds are of such tremendous proportions that entire creek valleys may be destroyed or greatly devastated so that the future utilization of the valley by the inhabitants is gravely menaced.

These floods occur in the summertime and may result from storms of tropical hurricane origin or from convective thunderstorms. The hurricane type is likely to produce major floods on the larger streams as well as on the smaller. Such a storm occurred in mid-August 1940 in the eastern Tennessee River basin causing record floods on many of the headwater streams. The summer thunderstorms generally cover less area and are likely to happen over any small mountain watershed. In 1938, such a storm visited the Webb Mountain region a few miles east of Gatlinburg, Tenn. Another storm of the same type occurred late in August 1940 with greatest intensities west of Asheville and followed by only 17 days the previous great hurricane storm. Maximum floods resulted on many small watersheds in western North Carolina.

To illustrate the characteristics of such storms and the resulting flood run-off and damages, these three storms will be briefly discussed with reference to their effect on small mountain watersheds of less than 100 sq mi. Intense summer storms in this region are often accompanied by huge slides of material from the mountain sides and an understanding of this phenomena is prerequisite to an appreciation of the flood problems in the small mountain valleys.

These so-called slides are not actually true slides in most cases, but are believed to be the result of a heavy concentration of rainfall over a limited area of mountain side, usually starting high up on the mountain. The large volume of water loosens the soil and rocks where it strikes and starts flowing down the mountain at a high velocity, scouring out the material in its path often down to and sometimes into bedrock. Waste from logging operations and trees add to the material as it moves rapidly down the steep slope. The force of the mass of water, boulders, and timbers is so great that everything in its path is washed away.

Fig. 1 shows the side of a mountain valley which was subjected to heavy rainfall during August 1940 with the resulting development of the several slides shown. These start near the top of the mountain and follow the general drainage channels into the main draw. The bifurcated head of one slide, which flowed down over valuable agricultural lands doing considerable damage, is shown in Fig. 2. The soil mantle and intermixed rocks and boulders are scoured out down to the underlying rock.

On the night of August 4-5, 1938, a series of intense thunderstorms occurred in the Great Smoky Mountains along the Tennessee-North Carolina line in the general vicinity of Gatlinburg, Tenn. Rainfall over the storm area reached from 8 to 12 in in about 3 to 4 hr time and probably exceeded these amounts in the higher altitudes where no means of measurement existed.

The most severe of these storms occurred over Webb Mountain. Illustrative of the devastation caused by this storm is the damage done in Matthews Creek valley. This creek lies between two mountains, is about 3.5 mi long, and has a drainage area of 2.4 sq mi. The creek was normally a peaceful stream about 5 ft wide and a foot or so deep and bordered by bottom lands varying generally in width from 100 to 600 ft, which were in cultivation prior to the storm. The upper mile of the creek has a fall of 500 ft per mi, the next 2 mi about 150 ft per mi, and the lower reaches about half that much. Some of the mountain slopes bordering the creek were cleared for pasture or cultivation, and the upper slopes were mostly in second growth timber which had been burned over.

The intense rainfall over this small mountain valley with steep slopes resulted in rapid concentration and extremely heavy run-off. Scores of slides occurred bringing down tons of boulders and rocks into the valley there to deposit (Fig. 3). Bottom lands that had been producing good crops were covered up to several feet deep with rocky debris from one end of the valley to the other. Huge

Paper presented before the Soil and Water Conservation Division at the annual meeting of the American Society of Agricultural Engineers at Knoxville, Tenn., June 1941. Author: Head hydraulic engineer, Tennessee Valley Authority.

Fig. 1 (Left) A mountain valley subjected to excessively heavy rainfall, showing the resulting development of several slides • Fig. 2 (Right) The bifurcated head of one of the slides shown in Fig. 1 which flowed down over valuable agricultural lands doing considerable damage

masses of drift piled up at several places. Houses, barns, sheds, a mill in the path of the flood were demolished. Livestock was lost. But the greatest catastrophe was the ruining of the good bottom lands for cultivation.

Several other small mountain valleys in the Webb Mountain region were subjected to intense rainfall and were flooded and damaged somewhat less than the Matthews Creek valley. Along one small stream, a cabin in the valley was demolished by the flood and eight people lost their lives.

Run-off rates resulting from this storm were very high on many small streams. It is difficult to estimate run-off from one of these extreme storms, but determinations made following the flood indicate rates of 2,000 to 3,000 cfs per sq mi for areas less than 1 sq mi, and for areas up to 5 sq mi as much as 800 cfs per sq mi.

On August 13 and 14, 1940, the eastern section of the Tennessee River basin was visited by a hurricane storm which covered a large area in Tennessee, North and South Carolina, and Virginia. Flood losses amounted to several million dollars. On many small headwater streams all past flood records were broken.

During the period August 8 to 15, 1940, a tropical storm of hurricane intensity moved inland over Georgia and South Carolina. The path of this storm was unusual, in that the storm moved inland a considerable distance and then recurved, describing the greater portion of a circle.

As the storm approached and moved parallel to the southern Appalachian Mountains on August 13 and 14, very heavy rain occurred causing floods on the headwaters of streams originating in the mountainous regions on both slopes of the Blue Ridge Divide. From 12 to 16 inches of rain fell at several centers in the mountains. Increased vertical motion caused by the physiographic features of the mountainous regions caused rainfall increments in addition to those produced by the storm. This resulted in the excessive amounts of precipitation observed. The intense rainfall was concentrated over the mountain divide between the Gulf and Atlantic drainage, and there was a rapid decrease in rainfall within a short distance either way from the divide.

The duration of the storm varied considerably at different points of its path. The greater part of the precipitation generally occurred within 40 to 50 hr. The hourly distribution and intensity of rainfall were recorded at each of 32 recording rainfall stations in the mountainous area of the eastern Tennessee Valley. The maximum hourly intensity was 1.2 in at Tray Mountain, elevation 3900 ft, and 1.28 in at North Fork, elevation 2950 ft. Practically all other intensities were less than 1 in per hr. Continued steady rainfall with intermittent concentrations of intense rain are characteristic of this storm.

Flood stages resulted in the streams in the eastern part of the Tennessee Valley and were highest in the headwater streams. The steep rugged mountain topography, influential in causing the heavy rainfall, also is favorable to high rates and volumes of run-off. The small streams rose rapidly to sharp crests of short duration with very high rates of run-off; for example, a peak discharge of 3,800 cfs per sq mi was observed on Dutch Creek, drainage area 2.4 sq mi, in the Watuaga River basin. The floods diminished in relative magnitude downstream in all cases. On headwater streams of less than 100 sq mi in drainage area, run-off rates were among the greatest experienced in the eastern United States. Streams having small drainage areas had high crest discharge rates per square mile, but excessively high rates did not occur over areas of 100 sq mi or more.

Outside of the Tennessee Valley on the eastern side of the Blue Ridge, the U. S. Geological Survey has collected much valuable run-off data which will be published in a water supply paper now being prepared. The Survey found many very high rates; for example, on one area of 50 sq mi, a discharge of 71,500 cfs, equivalent to 1400 cfs per sq mi.

Prior to the flood, precipitation generally throughout the area had been subnormal. For the seven months preceding the flood the deficiency was 3.8 in, and for the portion of the water year preceding was 9.9 in. Ground water levels were abnormally low and base flow in streams was correspondingly low. Since this was a summer storm, interception and transpiration by vegetation was greater than during a winter storm. All of these factors tended to reduce run-off.

Damages along the small mountain valley streams were in many cases large and destructive to land and property.

During the night of August 29-30, 1940, an extremely heavy rainstorm occurred over the southern Appalachian Mountains in eastern Tennessee and western North Carolina. This storm developed locally over the region, and there were no definite indications of such a storm on the weather charts either prior to or subsequent to the appearance of the storm. A broad and relatively deep current of moist, tropical air had been flowing over this region for a number of days producing scattered showers and thunderstorms. During the night of August 29-30, a mass of cool polar air moved southwest along the Atlantic coast. A strong southerly current carried the tropical air up the steep surfaces of the polar air, resulting in heavy shower activity. Physiographic conditions undoubtedly aided in producing the rain.

Fig. 3 (Left) A slide caused by intense rainfall which brought down tons of boulders and rocks into the valley • Fig. 4 (Center) Bottom lands along this creek were destroyed by being covered with rocks and debris • Fig. 5 (Right) Corn growing on rock covered bottom land

Following the mid-August storm by only two and one-half weeks, the storm of August 29-30 for the second time deluged the Blue Ridge area with unusual amounts of rainfall. Unlike the first storm, this one was limited to the Blue Ridge and adjacent areas and was approximately a one-day storm instead of one extending over several days. Total rainfall at the centers was not quite as much as during the earlier storm, but practically all the rain fell in about 24 hr instead of being distributed over two or three days. Maximum amounts of 12 or 13 in in 20 to 28 hr occurred.

The hourly intensities for this storm which were observed at 32 recording stations in the mountain region, were heavier than in the mid-August storm. The maximum hourly intensity recorded was 2.54 in at Mt. Pisgah, elevation 5300 ft. Intensities in excess of one inch per hour occurred at several other stations.

This storm brought streams within the zone of intense rainfall to high flood stages, in some cases the highest ever experienced. Pigeon River at Canton, which had broken previous flood height records in the mid-August storm, reached even higher and unprecedented stages in the late August flood, thus experiencing two record floods within 17 days. As in the first storm, high rates of run-off on many streams with drainage areas of less than 100 sq mi were among the greatest experienced in the eastern United States.

The extremely high rate of nearly 10,000 cfs per sq mi from a drainage area of 1.3 sq mi was experienced on Big Creek near Canton, N. C. This occurred along with heavy erosion as a result of intense localized rainfall at the head of the creek on the mountain side. The U. S. Geological Survey on this stream found a rate of 4500 cfs per sq mi on a stream of 0.4 sq mi drainage area in the same vicinity as Big Creek.

The upper Little Tennessee River basin received rain of 10 to 13 in along the Blue Ridge divide. This amount was the greatest reported from the storm area and was particularly destructive on the small watersheds in that region. One of these small watersheds where great destruction was experienced is that of Caney Fork. The run-off near the lower end of this stream where the drainage area is 37.5 sq mi reached a peak of 21,700 cfs, a rate of 580 cfs per sq mi. Rainfall over this basin varied from 7 to 11 in with an average of 9.7 in. The heaviest rains occurred over the upper reaches of the Fork and probably were in excess of those measured.

Slides were numerous over the upper part of the watershed particularly on a small tributary, Sugar Creek. Bottom lands along this creek were destroyed by being covered with rocks and debris (Fig. 4) much as Matthews Creek had been in 1938. At the confluence of Sugar Creek and Caney Fork, a small settlement was completely washed away. The road up the Caney Fork valley was washed away in many places and all bridges were carried out. Bottom lands were filled over with rock and boulder deposits or scoured by the swiftly flowing water which cut across bends to make new channels where formerly had been good fields.

What happened on Matthews and other creeks in 1938 and on Caney Fork in 1940 is happening in lesser degree in other small mountain valleys in this region practically every year. When these disastrous storms do occur with destruction of bottom lands, the agricultural economy of the region is upset. For example, on Caney Fork a farm economy had been built up based on good land-use practices of pasturing the slopes along the valley and growing corn and feed crops on the bottom lands. Undisturbed by damaging floods, this valley was known as one of the best in the entire mountain section. Then came the 1940 flood, leaving in its wake many acres of scoured bottom lands cut up by new stream channels and other acres covered with a deposit of rocks and debris. The area of bottom lands which are available for feed crops has been materially reduced, thereby necessitating adjustments in the farming program for individual farms and for the region as a whole.

On Matthews Creek, the situation was even more acute since practically all the bottom lands were covered with deposits of rock and debris. And yet today, three years after the disaster, the mountain people are still living there and struggling to make a living out of the land. Almost beyond belief, crops are being grown to a limited extent on the rock covered bottom lands. Fig. 5 shows a cornfield in late June 1941, which is growing out of the rocks with the aid of "tobacco" fertilizer. This illustrates the resourcefulness and spirit of the people in overcoming obstacles. Another result of the destruction of bottom lands has been the clearing and cultivation of steep hillsides with all the attendant evils of accelerated soil erosion.

The losses due to these small mountain valley floods is not in itself large by comparison with losses due to great floods on major streams, but to the farmer making a living out of the land in one of these valleys it is of prime importance. Whether anything can be done to prevent this type of damage is a question for which I have no answer. However, the problem is an intriguing one, and, on the theory that nothing is impossible, it may be that either protective measures may be devised or some feasible means discovered for reclamation of the bottom lands after a flood.

Seed Drier Uses Infrared Electric Lamps

(Continued from page 423)

While this new equipment may need further development to increase its mechanical efficiency, there is no reasonable doubt at this stage of its development that the conditioner does dry seed economically without injury to germination.

SUMMARY

1 This paper gives a preliminary report of an infrared electric seed drier and conditioner developed for red fescue and other seed.

2 Preliminary studies indicated that seed could be dried by infrared radiant energy to the safe storage moisture content of 10 per cent or less, in 2 to 5 min under static conditions (Fig. 1, Table 1).

3 There was no appreciable injury to seed, oven dried at 200 F, for various periods of time, ranging from 3 to 30 min (Table 2).

4 A temperature of 200 F was possible by the use of 250-w infrared lamp over a reasonable area (Fig. 1).

5 The capacity of the infrared seed drier and conditioner, in pounds per hour for specific speed and material, is given in Table 3.

6 Under the conditions of test, it was possible to reduce moisture content of the seed to a safe figure with a 4-min 50-sec exposure.

7 Germination tests of the dried seed showed that there was no appreciable injury to viability (Tables 4 and 5).

Case Studies in Low-Cost Housing

By Deane G. Carter
FELLOW A.S.A.E.

THIS PAPER summarizes a series of nine case studies in low-cost housing conducted at the Arkansas Agricultural Experiment Station from 1934 to 1941. Each case represents a new farmhouse built from plans of the Arkansas station, for which complete labor, material, and cost records were kept and the construction supervised.

The primary objective was to investigate the cost factors and determine the methods of cost reduction, principally through the utilization of native materials and unskilled labor. In addition, certain of the studies tested the value of special construction methods and the effectiveness of technical aid and educational help in cost reduction.

Limitations Of The Study. The houses covered by this investigation were erected over a period of several years, in various areas of Arkansas and under varying conditions of quality, materials, financial limitations, size, labor quality, and equipment. Therefore, the data apply only to the individual cases. It is not possible to make direct comparisons, nor to base conclusions on totals and averages. On the other hand, all of the houses were adequate in the essential structural qualities. Material costs and wages were relatively uniform throughout the period of study.

Brief Description Of Cases Included. Following is a summary of the essential features of the nine houses covered by the study:

CASE 1. A high quality, 8-room, 1½-story, stone veneer house, with full basement, bath, and complete storage equipment. The size was 28 by 44 ft in the main part with a 10 by 22-ft wing. Materials included concrete base, stone fireplace, pine framing, asphalt composition roof, oak floors, and standard millwork.

CASE 2. A substantial frame house, with 5 rooms, 2 porches, closets, bath space, and cabinets. One story high. Size 29 by 32 ft. Materials include concrete foundation, concrete porch floors, rough framing and sheathing, cedar shingles, oak living room floors, pine siding, paint finishes, and standard millwork.

CASES 3 and 4. Small, 4-room, 1-story frame houses, 24 by 26 ft in ground area. Identical, except Case 3 was all new materials; Case 4 included some salvage. Minor variations occurred in the arrangement of porches and closets. Qualities were the same as in Case 2.

CASE 5. A high quality, fully-equipped 4-room house, with bath, plumbing, electricity, kitchen cabinets, asbestos-cement roof, and standard construction throughout, except rough lumber for frame and sheathing. The ground area was 24 by 32 ft.

CASE 6. A 3-room tenant house, with bath space, electric wiring, screened work porch, size 18 by 32 ft. Experimental construction included concrete foundation, concrete slab floor, double-wall monolithic concrete exterior and main partition walls. Douglas fir plywood was used for partitions, ceilings, and kitchen cabinets. Constructed entirely with unskilled youth labor.

CASE 7. A small, 4-room, 1-story farmhouse. The size was 26 by 28 ft, with stone veneer wall, rough lumber frame, concrete slab floor, salvage lumber ceiling, and metal roof. This house represented minimums of material cost and quality. No skilled labor was used. Study was made of the value of technical aid in planning and construction.

Research Paper No. 723 Journal Series, University of Arkansas, approved by the director of the Arkansas Agricultural Experiment Station. A bulletin entitled "Investigations in Low-Cost Housing," is scheduled by the Arkansas station, in which the details of the study are presented. Author: Formerly professor of agricultural engineering, University of Arkansas, College of Agriculture.

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CASE 8. A 4-room and bath, 1-story, stone veneer house, 27 by 36 ft. Construction was done entirely by the owner and his family with some technical assistance. Minimum cash expenditure for materials. This case represents the creation of housing by the efforts of the owner and the products of the farm. Commercial materials purchased amounted to $184.40. About $150 was spent for transportation, shingle making, mill costs, and miscellaneous costs necessary to process the native materials.

CASE 9. (Erected in cooperation with the U. S. Department of Commerce, represented by Major Howard A. Starret, who is joint author in reporting this case.) A 4-room, 1-story house, with bath, plumbing, electricity, pantry, cabinets, fireplace, and two porches. This house was erected as an experimental design to use solid lumber in the form of rough 2 by 4-in unseasoned dimension in walls, floors, and ceilings. The construction was handled throughout by unskilled farm labor under supervision. All gravel, lumber, logs, and stone were supplied by the farm on which the house was erected. The cash expenditure of $416.43 was for plumbing, electricity, installation cost, and structural materials, such as roofing, millwork, cement, and hardware that could not be supplied by the farm.

The qualities of strength, durability, equipment, and size, in relation to the low cash cost, give a high value to the experimental study. The radical departure from conventional methods resulted in some defects; however, most of the difficulties might be overcome with further experimentation.

Scope Of The Study. Cost reduction in terms of cash expenditure is not inconsistent with improvement in housing quality. Savings effected by the use of available native materials and family labor are utilized for the purchase of materials and equipment that could not otherwise be afforded.

The data presented are based upon the actual expenditures for the nine houses; however, in order to make comparisons, equivalent values were given to the non-cash contributions. Unskilled labor was valued at 25c per hour. Salvaged or rough lumber was estimated at $15 per 1,000 board feet. Stone was listed at $1 a perch (16⅔ cu ft), and sand and gravel, $1.33 per yard.

The tables presented include the results in terms of total and unit house values, cash cost reduction and the value of the non-cash contribution, division of values between labor and materials, and the amount and value of unskilled labor.

TABLE 1. TOTAL COST OF EACH OF 9 EXPERIMENTAL HOUSES

Case No.	Plan number	Total value	Per room	Per square foot	Per cubic foot
1	78345	$2,989.46	$373.68	$2.05	9.9c
2	75141	1,356.20	271.25	1.46	9.8
3	74388	1.052.29	264.00	1.70	11.2
4	74388	904.59	228.14	1.45	9.7
5	94008	1,400.00	350.00	1.90	14.0
6	93120	1,220.00	406.86	2.12	20.0
7	74149	585.65	146.41	.80	6.2
8	74266	1,153.55	288.00	1.12	8.0
9	94223	1,016.93	254.23	1.41	10.0

House Values. The total costs in Table 1 for each of the nine case studies include all items, including purchased materials, hired labor, and the contributed values. In a general way, Cases 1 to 5 represent conventional houses, and the approximate average cost of 10.9c per cubic foot is consistent with the results obtained throughout the area. Case 5, at 14c per cubic foot, represents a completely modern, well-finished, adequate house. Cases 7, 8, and 9

indicate the cost reduction resulting from a maximum use of low-cost materials and labor.

Cost Reduction. All stone, sand, gravel, and rough lumber were classified as a "home contribution". Throughout Arkansas, and in other areas of similar character, these materials are available on the farms in many communities.

TABLE 2. TOTAL COST AND DIVISION BETWEEN POSSIBLE NON-CASH CONTRIBUTION AND NECESSARY CASH EXPENDITURES

Case No.	Total calculated value	Value of possible home contribution		Cash expense necessary	
1	$2,989.46	$883.00	29.8%	$2,106.46	70.2%
2	1,356.20	296.25	21.7	1,059.95	78.3
3	1,052.29	203.75	19.3	848.54	80.7
4	904.59	203.75*	22.2	700.84	77.8
5	1,400.00	286.17	20.4	1,113.83	79.6
6	1,22[illegible].00	600.00	48.5	620.00	51.5
7	585.65	265.15	46.2	320.50	53.8
8	1,153.55	818.65	70.0	334.90	30.0
9	1,016.93	600.50	59.0	416.43	41.0

*Plus some additional value in salvage

It was assumed that all common or unskilled labor might be contributed by the farm operator. It is not assumed that low-wage labor is more economical, if all labor must be hired. In fact, some analyses of the data indicate that the lowest net cost for labor was attained when a high proportion of skilled labor was used (Cases 7, 8, and 9, Table 3).

From Table 2 it may be noted that in the conventional houses (Cases 1 to 5), about one-fourth of the house value is classified as a non-cash contribution of labor and materials. The average of the "homemade" houses (Cases 6 to 9) indicates that more than one-half the total value was in non-cash items.

TABLE 3. DIVISION OF HOUSE VALUES BETWEEN LABOR AND MATERIALS

Case No.	Labor		Materials	
1	$1,178.04	39.4%	$1,811.67	60.6%
2	451.25	33.4	904.95	66.6
3	347.30	33.0	705.09	67.0
4	353.52	39.0	531.07	61.0
5	483.15	34.5	916.85	65.5
6	488.00	40.0*	732.48	60.0
7	182.65	41.1	403.00	58.9
8	625.00	54.0	529.55	46.0
9	603.00	59.0	412.07	41.0

*Estimate, exact labor record not available

The methods of cash cost reduction, used in one or more cases, included (1) concrete slab floors on earth fill; (2) native stone foundation, footings, porch floors, and flues; (3) monolithic concrete exterior walls; (4) homemade doors, frames, and cabinets; (5) homemade wood stains and whitewash; (6) rough lumber construction, and (7) extensive use of unskilled labor.

Division Between Labor And Material. A fair assumption for the usual types of construction in the area is that the labor item averages 37.5 per cent of the total, and material costs amount to 62.5 per cent. This is equivalent to counting labor as 60 per cent of the material cost. Table 3 shows the division between the labor and material input. In this analysis, the conventional division prevailed in Cases 1 to 6 with labor ranging from 33 to 40 per cent, and materials from 60 to 67 per cent. Cases 7, 8, and 9, constructed with virtually 100 per cent unskilled labor had a high labor proportion.

TABLE 4. LABOR DIVISION BETWEEN COMMON (UNSKILLED) AND SKILLED TYPES

Case No.	Common labor		Skilled labor		Total labor	
1	2,573 hr	59.1%	1,780 hr	40.9%	4,353 hr	$1,178.04
2	690	53.6	603	46.4	1,293	451.25
3	453	48.4	483	51.6	936	347.30
4	675	61.7	419	38.3	1,094	353.52
5	565	46	687	54	1,252	483.15
6	1,952	100	—	—	1,952	488.00
7	910	100	—	—	910	182.65
8	2,500	100	—	—	2,500	625.00
9	1,490	90.9	150	9.1	1,640	603.00

Use Of Unskilled Labor. Table 4 indicates the division between common or unskilled labor and skilled types. In the first five cases, representing the more conventional houses, about one-half the total labor hours were unskilled. The use of unskilled labor exclusively was accompanied by a substantial amount of planning, technical supervision, or educational aids. It was concluded from the studies, however, that a satisfactory quality of farm housing could be secured in cases when fully one-half the labor required was performed by unskilled workmen, or by the owner's family.

Examples of low cost farmhouses. (Right) *Case 6.* Concrete, plywood, and native material framework was used in this eastern Arkansas tenant house. (Below, left) *Case 7.* In this house maximum cash cost was reduced by home labor and materials. Technical assistance improved design and structural quality. (Below, right) *Case 9.* This house embodies experimental solid wall, floor, and ceiling construction. Only farm labor used, except for plumbing and wiring

The Design of Plot Experiments for Measurement of Run-off and Erosion

By Dr. A. E. Brandt

AT THE beginning of this discussion of the design of control plot experiments, I wish to make clear my understanding of what constitutes research and the aspects of research which I shall discuss. I find it convenient to think of research as consisting of three phases. In the first phase ideas are born, ideas which so occupy the research worker's mind that he forgets to put on his tie, lolls in his bath to the disgust of other members of the household, elevates his feet to his desk and stares off into space, or argues seriously with his colleagues until an idea has been whipped into an hypothesis. An hypothesis having been formed the scientist is ready to conduct an experiment to test it critically, the second phase of research. In case the results of the critical experiment lead the experimenter to retain his hypothesis, he, or his readers, will, if the theory resulting is of economic value, subject it to rather extensive checks to determine how generally the results apply. This is the third phase.

It must be evident that in the first phase research workers will find it very difficult indeed to write up a working plan that will satisfy the powers that be and thus result in money being allotted for the work. It must be equally evident, however, that lack of funds and official sanction cannot keep a true scientist from indulging in this phase of research since such a large part of it is the product of his own thinking. It is this phase of research, in which the worker gropes in all directions for leads which give rise to hypotheses and at times makes remarkable discoveries, that is called true or fundamental research by many people. Unfortunately some make the mistake of thinking this research is fundamental because it does lack direction and of classifying all aimless experimentation as fundamental research.

Although a very large proportion of a research worker's time may be consumed by this first phase, I shall not discuss it further, for the statistician can offer scant assistance at this stage, though some knowledge of that mode of thinking or branch of logic called mathematics will prove useful to the experimenter. In the second phase, however, the statistician can render real assistance in designing critical experiments and in analyzing the results from them. I shall spend my time, then, on this phase, and if I speak as though it were all there is to research, it will be for the sake of brevity and convenience rather than because I do not know of or do not appreciate the importance of the other two phases.

The first essential of an experiment is a definite question or objective. Many experiments are started without a definite objective in hope that the data collected will furnish both the questions and the answers. In discussing the plan for some proposed research which lacked a definite objective one man said, "It is likely that some of these debatable points can be adjusted after the test gets under way and that the test will provide certain valuable information." Other experiments are conducted under plans with such broad objectives that most anything may be done.

Having decided upon a definite objective the experimenter must consider all the possible outcomes and declare his position. Some of you may feel that this is contrary to the open-minded attitude which the true scientist should maintain. A definite stand gives direction to an investigation and need not prevent the investigator being open-minded and fair in his research, if at the time he states his position he will state the conditions under which he will change that position. In order to be entirely fair and open-minded this statement must be made at the start of the experiment and not after the data have been collected. A gauge of the researcher's open-mindedness is afforded not by his statement of position but by his statement of the results which will cause him to change that position.

For any true experiment there must be several possible results. These possibilities should be considered and the interpretation to be placed on each decided upon before the data have been collected. Further, the argument by which the accepted interpretation is to be sustained must be known. This seems to place a heavy responsibility upon the researcher, but a major part of the load may be shunted by using a properly designed experiment. In addition to measuring the difference between two or more treatments, breeds, or other controlled variables, the experiment must furnish a criterion by which the degree of confidence that can be placed in the result may be judged. A properly designed, self-contained experiment will furnish both the treatment difference and the criterion.

Before going farther let us make certain that we all have the same understanding of what an experiment is. An experiment has been defined as "a trial made to confirm or disprove something doubtful". Now anyone with average intelligence can conduct an experiment, that is, can record certain quantitative facts relative to it. As far as real research is concerned, however, the job at this point is frequently less than half done, as it is necessary that the data be interpreted. No doubt you will all agree that the best guarantee that proper scientific care has been exercised in conducting an experiment and that the results have been properly interpreted is a man of proper training and experience, or, in other words, that improper personnel can render results entirely useless and often misleading. Improper design, to at least as great degree, may lead to obscure or misleading results.

As an example, let us suppose that we were to compare three types of bin for storage of wheat. For the test, one of each of the three types of bin was built and placed so that no one would be specially protected by the others or favored by other environmental conditions. The three bins were then filled on the same day under as nearly as possible identical conditions with wheat that was as uniform in regard to all characteristics that might affect storage as the ingenuity of the experimenter could provide. Using the most precise instruments obtainable, temperature, humidity, and other pertinent information were secured and at definite time intervals the storage damage was meas-

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ured by determining the rancidity of the oil in the wheat germ. In spite of all this care, the result of this test has limited scientific value due to the fact that the design used is generally inadequate and yields unreliable and frequently misleading results.

Now I may have done just what the statistician is always being accused of doing, shaken your confidence in some of the common methods of experimentation. My chief job in this discussion is to try to show you how critical experimentation can be done and why the designs used achieve the desired ends. In all adequate designs, regardless of name, the purpose is two-fold, namely, to determine the difference of effect and to provide a valid estimate of the variability of effects of treatments on the same plot, the so-called experimental error, random error, sampling error or just error. For all these designs there are two requisites, replication and randomization. There are two purposes in replication, increasing precision and providing an estimate of error. There are other ways of increasing the precision of an experiment such as better materials, instruments, and workers, but no other way of providing an estimate of error. The sole purpose of randomization is to insure that the estimate of error be valid.

SELECTION OF A DEFINITE KIND ESSENTIAL IN DESIGNING A RUN-OFF PLOT EXPERIMENT

In designing a run-off plot experiment, we must select a definite kind for there are many kinds and no one design will fit all of them. Let us consider one for a vegetable or truck crop region where the soil is rather sandy, the slopes are not steep, and torrential rains are rather common. We shall have no difficulty in finding things to compare. The engineer may insist that the effects of length of slope, degree of slope, and direction of cultivation on run-off and soil loss must be determined. The soils man will insist that the effects of different amounts and kinds of organic matter and perhaps also of chemical or mineral fertilizers on run-off and erosion must be determined. The vegetable crops man will insist that the effects of different crops and of different methods of planting, cultivating, and harvesting those crops on run-off and erosion must be determined.

In fact, these suggestions and many others were made and discussed at some length before I was called upon for what assistance I could give in designing an experiment of this sort. Fortunately, limitations of space and money had resulted in the number of experimental factors being considerably reduced before I saw the proposed plan. To show some of the points considered and some of the steps taken in designing a control plot experiment, I shall quote from my files concerning the design of the proposed new experiment:

"Before a definite statement concerning the adequacy of the proposed design for this experiment can be made, more information than was obtained in your memorandum of October 7 is needed. In the first place, if it is known that the addition of organic matter produces the desired result with regard to the reduction of run-off and soil loss, the "so-called" check plot is not needed, but, if the value of the addition of organic matter is still an open question, check plots must be retained, but only a single untreated plot will yield only a limited amount of information on this question. With regard to the organic matter preservative, some information is needed as to quantity to be used and effects other than that of inhibiting decomposition of added organic matter. If this information is not available, some preliminary laboratory or greenhouse experiments probably should be conducted. In order to determine whether or not the direction of row should be included as an experimental variate and to what extent, one should know what direction is best (as inferred from previous experiments, of which there must have been many) and the common local practice. If the ideal direction and common local practice agree, this experimental variation might well be omitted. Unless a complete review of results with regard to effect of length of slope on run-off and soil loss indicates that this point is still in doubt, it would not seem advisable to devote space, time, and equipment to further tests of this point.

"Assuming that a thorough review of the best available information on all these subjects indicates that the variables mentioned in your memorandum and the questions implied therein are proper subjects for research, the real questions are: What answers will the design you have outlined yield and what will be their precision and validity? Your statement of the proposed design indicates that, for each replicate, 13 plots will be required as follows:

1 Check
2 10 tons of manure per acre
3 20 tons of manure per acre
4 10 tons of manure per acre with preservative
5 20 tons of manure per acre with preservative
6 10 tons of manure per acre with irrigation
7 20 tons of manure per acre with irrigation
8 Non-leguminous cover crop, rows with slope
9 Leguminous cover crop, rows with slope
10 Non-leguminous cover crop, rows across slope
11 Leguminous cover crop, rows across slope
12 Non-leguminous cover crop, double-length plots
13 Leguminous cover crop, double-length plots.

"In order to reduce somewhat the probability that this experiment will result in only a few tables of figures and some valuable experience for a few men, a minimum of two replicates should be used. On this minimum basis, 26 plots will be required.

"From the results obtained from plots 1, 2, 3, 8, and 9 and their replicates, the following comparisons can be secured with an estimate of sampling error for testing significance:

A Application of organic matter versus none. To be based on difference between mean of eight plots receiving organic matter but no other treatment and the mean of the two plots receiving no treatment

B 10 tons of manure per acre versus 20 tons per acre. To be based on difference between the mean of the two plots receiving 10 tons per acre and that of the two receiving 20 tons per acre

C Non-leguminous cover crop versus leguminous cover crop. To be based on the difference between the mean of the two plots having a non-leguminous cover and that of the two having a leguminous cover crop

D Manure versus cover crop. To be based on the difference between the mean of the four plots receiving manure and that of the four plots having a cover crop.

"The analysis would be made according to the following outline:

	Degrees of freedom
Block (replicates)	1
Treatment A	1
" B	1
" C	1
" D	1
Error	4
Total	9

"Selecting these plots from a larger experiment is not, in general, as satisfactory as to lay out an experiment solely for the comparisons shown above due to expected soil heterogeneity.

"From the standpoint of rapidity of decomposition of added organic matter the results from plots 2, 3, 4, 5, 6, and 7, and their replicates may be used. The analysis may be specified as follows:

	Degrees of freedom
Block	1
10 tons per acre vs 20 tons per acre (level)	1
Irrigated plots vs plots receiving preservative (treatment)	1
Irrigated and preservative plots vs natural (treatment)	1
Interaction of level and treatments	2
Error	5
Total	11

"For comparing the effect of direction of row, the results from plots 8, 9, 10, and 11 and their replicates are available. The analysis would be as follows:

	Degrees of freedom
Block	1
Direction of row	1
Kind of cover crop	1
Direction of row x kind of cover crop	1
Error	3
Total	7

"Finally, the effect of length of slope can be tested, though not with very high precision, by comparing the results for plots 8, 9, 12, and 13 and their replicates. The analysis would be as follows:

	Degrees of freedom
Block	1
Length of slope	1
Kind of cover crop	1
Length of slope x cover crop	1
Error	3
Total	7

"Though this experiment, or rather these experiments, could be conducted and tests made as indicated above, one's confidence in the conclusions would be weakened by some obvious faults in design. Instead of discussing these faults in detail, it may be more profitable to consider some designs not having them.

"Selecting two variations of application of manure, none and some; two of non-leguminous cover crop, none and natural growth; two of leguminous cover crop, none and natural growth; and two of direction of row, with the slope and across it; 12 plots are necessary for each replication of the treatments involving these variables. Using the following notation,

M_0 = no manure
M_1 = some manure, say, 16 tons per acre
N_0 = no non-leguminous cover crop
N_1 = natural growth of non-leguminous cover crop
L_0 = no leguminous cover crop
L_1 = natural growth of leguminous cover crop
D_1 = rows with slope
D_2 = rows across slope

the 12 treatments may be designated as follows:

M_0D_1	M_0D_2
M_1D_1	M_1D_2
N_0D_1	N_0D_2
N_1D_1	N_1D_2
L_0D_1	L_0D_2
L_1D_1	L_1D_2

"If these treatments are assigned at random, that is, by some mechanical scheme such as drawing numbers, to the 12 plots in each replication, a valid basis for testing the results is provided. The necessity of rerandomizing these treatments in each replication must be borne in mind. The questions that may be answered and the method of analyzing the results obtained from such an experiment, if properly randomized and conducted with two blocks or replicates, may be set forth as follows:

		Degrees of freedom
Block		1
Direction of rows, with slope vs across slope	(D)	1
Level of application of organic matter	(L)	1
Source of organic matter, non-leguminous vs leguminous cover crop, and cover crop vs manure	(S)	2
Direction x level	($D \times L$)	1
Direction x source	($D \times S$)	2
Error		15
Total		23

"This design yields much more precise tests than any of those above since the error term or criterion by which the significance of treatment differences is to be judged is based on 15 comparisons or degrees of freedom in contrast to 3, 4, and 5 in the others.

"Another experiment might be set up which would involve two levels of application of manure, say, 10 tons per acre and 20 tons per acre, and three treatments thought to influence the rate of decomposition of organic matter, namely, no treatment, irrigation, and use of preservative. Six plots per replicate are sufficient to accommodate the experimental variations involved. Using the following notation,

M_1 = 10 tons of manure per acre
M_2 = 20 tons of manure per acre
D_0 = no treatment of plots
D_1 = irrigation of plots
D_2 = application of preservative to manure

the treatments may be designated:

M_1D_0	M_2D_0
M_1D_1	M_2D_1
M_1D_2	M_2D_2

"The questions to be answered and method of analysis of results from an experiment involving these six treatments properly randomized may be specified as follows:

		Degrees of freedom
Block		1
Level of manure	(L)	1
Decomposition treatment; irrigation vs preservative, no treatment vs treatment	(D)	2
Interaction between level of manure and decomposition treatments	($L \times D$)	2
Error		5
Total		11

"It is by no means intended that the above discussion shall cover all possible adequate experiments that could be designed that would involve the experimental variations indicated in your memorandum of October 7. For instance, the last experiment given above might easily include direction of row. This rather extended discussion is presented in order to set forth some of the implications of the expression, adequate experimental design, through specific examples."

In spite of all the words written about this experiment, the final design, which was the result of a lengthy conference of a number of interested persons, differed consider-

ably from those offered in my memorandum. Likewise, it is superior to them in many ways. It was agreed that a few of the most important of the many variables that had been proposed should be studied in the simplest possible design. Those chosen were cover crop, none and some; manure, none and some; and length of slope, 70 ft, 140 ft, and 210 ft. These were combined into what is known as a 2x2x3 factorial requiring 12 plots for a single replicate. Since two replicates are being used, a total of 24 plots is required. On account of limitations of space and topography, it was impossible to arrange the treatments in two blocks in each of which a replicate could be accommodated. This feature causes some reduction in the efficiency of the experiment but not enough to invalidate the results.

The experiment is designed to evaluate the effects of a cover crop and of manure alone and in combination on three lengths of plot on run-off and soil loss under a system of truck cropping. In addition, information on the relation of run-off and soil loss to length of plot will be gotten. These questions and an outline of the analysis may be specified as follows:

Effects	Degrees of freedom
Cover crop	1
Manure	1
Interaction of cover crop and manure	1
Length of slope	2
Length of slope x cover crop	2
Length of slope x manure	2
Length of slope x cover crop x manure	2
Error	12
Total	23

A factorial design such as this one enables the experimenter to make very efficient use of his facilities, for every one of the 24 plots is used to evaluate the effect of a cover crop, all of them are again used in a different combination to evaluate the effect of manure, in still another combination the interaction of cover crop and manure is evaluated, and so on for the remaining treatment comparisons. That such multiple use can be made of the plots is made clear when one considers the way in which the treatment variations are combined. Of the 12 plots in a replicate that are treated differently, six are not planted to a cover crop and six are, but in each set of six three do not receive manure and three do, and these four sets of three plots each are symmetrical with respect to length, one in each set being 70 ft long, one 140 ft long, and the third 210 ft long. This symmetrical arrangement may be summarized as follows:

No cover crop	No manure	70 ft long 140 " " 210 " "
	20 tons of manure per acre	70 ft long 140 " " 210 " "
Cover crop	No manure	70 ft long 140 " " 210 " "
	20 tons of manure per acre	70 ft long 140 " " 210 " "

Now some of you may be shaking your heads about this design for you may feel that but one of the essential conditions should be allowed to vary, the others being held constant or controlled. Most of you, I am sure, have been taught, as I originally was, that the scientific approach to investigation is based on the abstract isolation of factors. If rather simple laws governing the relations of variables under consideration are known, it is possible to isolate a certain factor or variable for demonstration purposes or for routine determinations.

It must be obvious, however, to the members of this group that in genuine research there are many possible factors and that the laws governing the relationships between them are seldom simple and almost always unknown. Regardless of how many variables are controlled, it is practically impossible to hold constant all but one. The usual procedure for workers who try to follow this approach is to vary one factor, control those that are easily controlled, and ignore the rest. The difficulty of controlling all variables but one is almost certainly not as great as that of selecting a variable to control that will exert its influence independently of all other possible factors that might vary. Perhaps my chief purpose in selecting this particular experiment as an example was to show you that this concept of the scientific method may be wrong and that in many cases an experiment becomes more efficient as it is made more comprehensive. By more efficient, I mean that more knowledge and a greater degree of precision may be obtained from the same number of observations and, I might add, the same expenditure of time and money.

Thus the symmetry in this experiment, which I have just pointed out, provides 12 plots on which no cover crop is planted and 12 on which a cover crop is planted. Any difference in run-off and soil loss between these two sets may be credited then to the particular respect in which they differ with due allowance for random or sampling fluctuation. The same condition exists with respect to the application of manure. Twelve of the 24 plots receive no manure and 12 receive 20 tons per acre, and the difference between the two sets may be assigned to the use of manure with proper allowance for sampling error. And finally, the three groups of 8 plots each 70 ft, 140 ft, and 210 ft long provide an estimate of the relation of length of slope to run-off and soil loss because they are symmetrical with regard to the other two variables, cover crop and manure. For each of these three main comparisons the same precision is obtained as though the entire 24 plots had been used to test but one of the three variables. Thus every plot yields information upon each of the main questions which the experiment was designed to test.

If these questions had been tested separately, a total of 72 plots would have been required to obtain the same information given by the 24 plots when combined as they have been to form a factorial experiment. This is not the only advantage of the factorial design, however, for the separate tests would yield no information on the possible interactions between the three variables. For example, if the use of 20 tons of manure per acre reduces run-off and soil loss when no cover crop is used but is not effective, is less effective, or is more effective when a cover crop is used, this fact could be determined only by testing the application of manure in the presence and absence of a cover crop which is, of course, one of the purposes of the factorial design. Of the 24 plots, 6 receive manure and a cover crop and 6 receive neither providing a group of 12 to compare with another group of 12, of which 6 receive manure but no cover crop and 6 receive a cover crop but no manure, thus providing a comparison of two sets of 12 plots comparable in all respects, except the one in question, that is, whether the effect of *(Continued on page 436)*

How Much Rent Can a Cow Pay?

By M. Glen Kirkpatrick
ASSOCIATE MEMBER A.S.A.E.

THE TITLE of this paper suggests a corollary of a more general proposition, namely, whether farm buildings should be built on the basis of what animals can afford, or on the basis of what their owners would like to have.

The conception of the function of farm buildings has changed somewhat in the past 50 years, and that affects somewhat the approach to the subject of economy of farm buildings. For instance, I find in a copy of "Farm Journal" published in 1888, plans for a barn designed by Professor I. P. Roberts, who was head of the agricultural college at Cornell University. An article accompanying these plans stated that the barn was patterned pretty much after a building in use at Cornell University.

The barn was 28x36 ft. Posts were 25 ft to the eaves. The peak of the roof was 45 ft from the ground. There were two stories and a haymow in the building. Hay chutes from mow to first and second floors were built outside the building. The first floor had stalls for cattle across half the building and a manure pit across the other half. Directly above the manure pit were stalls for horses, with openings through which horse manure could be cleaned into the manure pit below so that the combination of horse and cow manure could be worked over and mixed together by the dairy cattle. Floors of horse stalls were made watertight with asphalt.

Directly above the first-floor cattle stalls was a threshing floor and alongside was floor space for tools and implements. The space above the threshing floor and implement floor was open to the roof. Accompanying the plans was the statement that, with a few minor changes, "this barn would embody our idea of what a barn should be, namely, a center around which the whole farm revolves, in which all animals and implements are housed, to which all crops are brought, and from which, after having descended from roof to basement by gravity, they are again taken as manure in its very best condition."

Specialization in agriculture has, on many farms, done something to that conception of one building to serve as a headquarters for chores. Cows producing 1,000 lb of butterfat a year, hens laying 200 or 300 eggs a year, sows producing ton litters, have asked for buildings designed especially for the job. Buildings for animals producing far less than those amounts have followed pattern in many cases.

Unfortunately in many cases the question of economy has been overlooked or minimized in design and construction of these special buildings, as well as in the general barn which houses the dairy herd. Such buildings raise the question of where economy ends and luxury begins. Here and there one finds a barn whose cost is out of line with the value of the land or with the income-producing ability of the dairy herd. Such buildings do serve to give the farm an appearance of prosperity, even though the farmhouse may not. Some farmers building such barns have overlooked the fact that the barn which his herd can pay for out of income is something different from what his neighbor's herd can afford.

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Suppose we put the dairy herd on the same basis as the farm boy who goes to the city, gets a job, marries, and tackles the problem of owning or renting a home. He finds that he and his wife must live in a place they can afford and pay for out of their income. If they rent, they have to figure that one month's rent can not be much more than one week's income. If they buy a home, they are advised to get something costing no more than twice their annual income — not much more, anyway. To go beyond this proportion of income means something else must give way (less money for food, clothing, recreation, etc.), or else there must be more income, and that is not always easy until after the boy has been on the job for a long time. The net result is a general agreement that the two should live within their means.

Money for a dairy barn is nothing more nor less than a loan to the dairy cow. Loaning money to a cow is no different from buying stock in a milk-producing factory or buying one of the bonds issued by a milk manufacturer. Hence, it is only logical that a cow should be loaned no more for buildings than she can pay back from her income, on which there are other demands such as feed, labor, veterinary fees, etc. Just as folks say "So and so has no business living in a house like that with *his* income," so it is pat to say that a herd of cows which scarcely pays feed bills can not afford to live in a barn with cork floors, or tiled walls, or with pergolas in the barnyard. The rent a cow pays *has* to come entirely out of income because cows do not have trust funds or rich uncles, can not expect Christmas bonuses or sweepstakes prizes, and thus far the government has not put them on relief.

Another way of looking at the question is to say that the dairy barn should provide everything that has been found beneficial regardless of the cow's ability to pay. In principle, there is no argument against this, but in fact it is necessary to realize that the very last word in a dairy building is not for the average cow which produces only 180 lb of fat per year. It doesn't settle the matter satisfactorily, either, to say that a dairyman should not keep cows giving so little milk, but should sell them to the butcher and get cows that are able to earn more.

True enough, an output of 180 lb of fat a year is too low to enable a cow to pay for an elaborate building. The man with cows like that has as much of a cow problem as a building problem. If the cow produced 300 lb a year, she could afford a better home with running water, electric lights, etc. There is no magic, however, that can boost the average production from 180 to 300 lb a year. It has taken over 20 years to boost the average from 160 to 180 lb per cow. At that rate, it would take 120 years to reach a 300-lb average for all dairy cows in the United States. That is too long a time for a cow to wait to start housekeeping in the style that she and her owner would like.

When the question comes down to the specific one of how much rent a cow can pay for buildings out of her income, you get a variety of replies, and we are frequently told that the question should be asked in some other form because there is no definite answer to a question like that. Judging by replies which I have received from dairymen and farm structures specialists within the past few months, there is no very definite idea as to what part of her income

a dairy cow can afford to pay for rent. Neither is there any general agreement as to how much the cow's owner can safely lend her to put into a new home.

An analysis of farm accounts and farm records shows how much cows are being charged for shelter and equipment in herds here and there. For instance, carefully kept records in 28 Kentucky dairy herds showed that cows were spending 5 per cent of the gross cost of producing milk for rent of shelter and equipment. In the ten lowest-producing herds of the twenty-eight this amounted to $1.67 per cow per year. In the ten highest-producing herds it amounted to $6.40. The average of all herds was $4.01.

To hitch these figures up to a 16-cow herd, multiply the rent figure by 16 for any one of those groups and see what a 16-cow herd could put into a new barn if the cows all decided to quit paying rent and buy. Assuming that a new barn would last 30 years, the monthly rent payments of those average Kentucky cows would add up to $1,924.80. For the 16 best cows they would add up to $3,072. For the 16 poorest ones, $801.60. But is it possible to build, for $801.60, a 16-cow barn that would last for 30 years? Or is it possible to build for $3,072 a barn as good as the best cows require?

Some other farm manager surveys in northeastern Iowa show an average buildings charge per year of $11 in herds producing 292 lb of fat per cow per year. Each cow in those herds was paying 7.5 per cent of her income for rent. In herds in the same area that averaged 232 lb of fat per cow per year, the buildings charge was $8.70, or 7.5 per cent of total annual income. In herds that averaged 162 lb of fat per cow per year the charge was $8.10 per cow, or 8.6 per cent of total annual income. For each $100 spent for feed on these farms, the total sales from dairy products varied from $152 down to $124.

On ninety-three carefully selected Illinois farms producing milk for the St. Louis market, each cow pays $7.72 per year for shelter. On the basis of milk, this amounts to ten cents per 100 lb. In New York, on farms where accurate accounts are kept, the annual buildings charge was just under $5 in 1939 (three cents of each dollar spent by the cows for feed, labor, etc.). Farm management analyses in Pennsylvania show an average building investment of $179.20 a cow; an annual rent of $18.25 per cow for use of buildings and equipment.

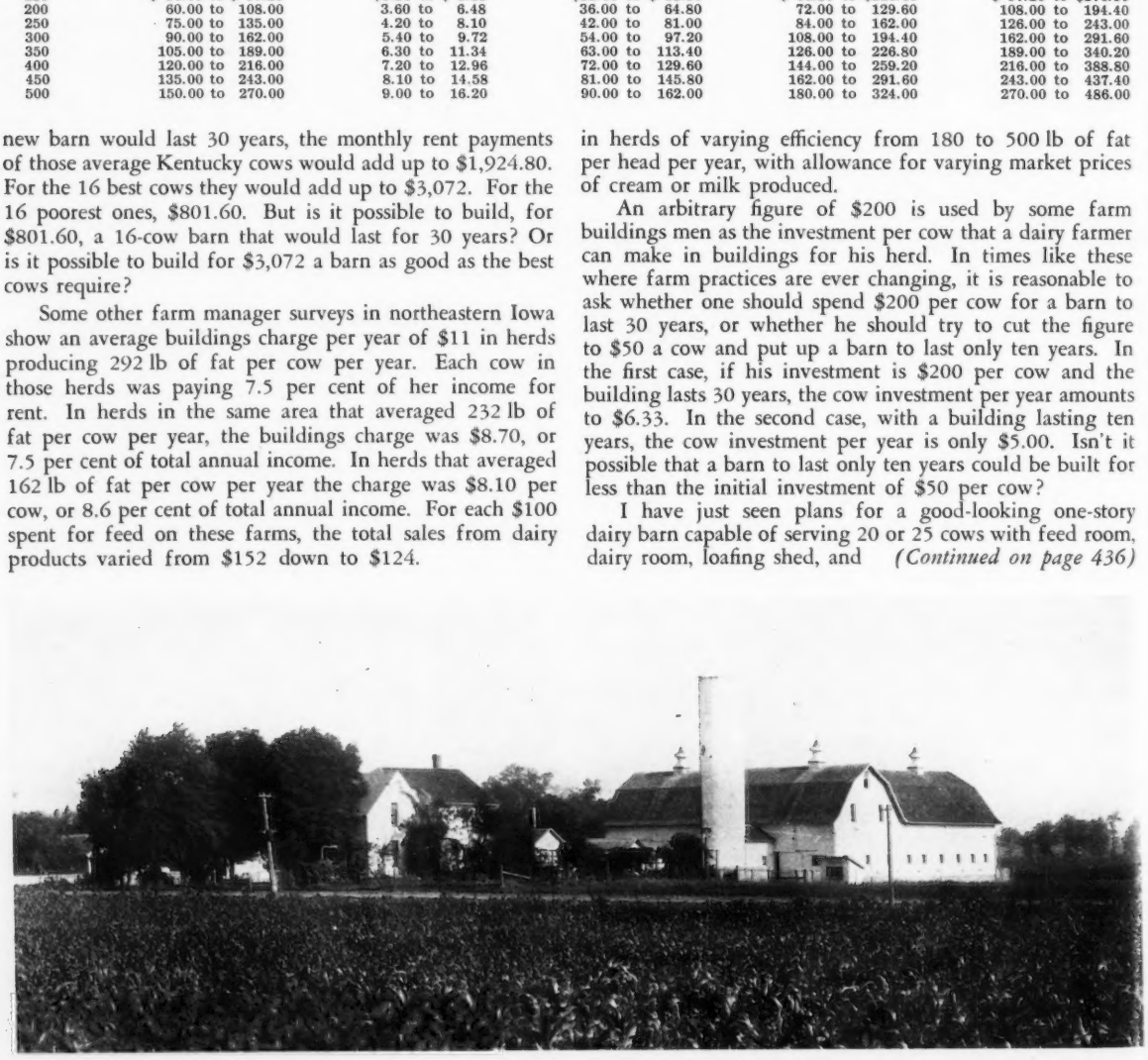
Suppose, on the basis of a low rent figure of 5 per cent of gross income, and higher figures of 7.5 to 8.6 per cent, we study the possibilities of new dairy buildings on a rent figure of 6 per cent of total annual income. The accompanying table gives the amounts available for building (no interest figures involved) over 10, 20, and 30-year periods, in herds of varying efficiency from 180 to 500 lb of fat per head per year, with allowance for varying market prices of cream or milk produced.

RENT MONEY AVAILABLE FOR BUILDINGS IN HERDS OF VARYING EFFICIENCY
(6 per cent of Gross Income)

Annual production per cow, lb	Total income per cow	Available annually for bldg. per cow	Available for building, 10-yr period	Available for building, 20-yr period	Available for building, 30-yr period
180	$ 54.00 to $ 97.20	$3.24 to $ 5.83	$32.40 to $ 58.30	$ 64.80 to $116.60	$ 97.20 to $174.90
200	60.00 to 108.00	3.60 to 6.48	36.00 to 64.80	72.00 to 129.60	108.00 to 194.40
250	75.00 to 135.00	4.20 to 8.10	42.00 to 81.00	84.00 to 162.00	126.00 to 243.00
300	90.00 to 162.00	5.40 to 9.72	54.00 to 97.20	108.00 to 194.40	162.00 to 291.60
350	105.00 to 189.00	6.30 to 11.34	63.00 to 113.40	126.00 to 226.80	189.00 to 340.20
400	120.00 to 216.00	7.20 to 12.96	72.00 to 129.60	144.00 to 259.20	216.00 to 388.80
450	135.00 to 243.00	8.10 to 14.58	81.00 to 145.80	162.00 to 291.60	243.00 to 437.40
500	150.00 to 270.00	9.00 to 16.20	90.00 to 162.00	180.00 to 324.00	270.00 to 486.00

An arbitrary figure of $200 is used by some farm buildings men as the investment per cow that a dairy farmer can make in buildings for his herd. In times like these where farm practices are ever changing, it is reasonable to ask whether one should spend $200 per cow for a barn to last 30 years, or whether he should try to cut the figure to $50 a cow and put up a barn to last only ten years. In the first case, if his investment is $200 per cow and the building lasts 30 years, the cow investment per year amounts to $6.33. In the second case, with a building lasting ten years, the cow investment per year is only $5.00. Isn't it possible that a barn to last only ten years could be built for less than the initial investment of $50 per cow?

I have just seen plans for a good-looking one-story dairy barn capable of serving 20 or 25 cows with feed room, dairy room, loafing shed, and *(Continued on page 436)*



Money for a dairy barn is nothing more nor less than a loan to the dairy cow. Hence it is only logical that a cow should be loaned no more for buildings than she can pay back from her income, on which there are other demands such as feed, labor, veterinary fees, etc.

A Poultry Ventilation Problem

By Dr. M. W. Emmel

FOR A number of years the author has been conducting investigations on fowl paralysis, leukemia, and allied conditions in chickens. It has been found that this group of diseases can be induced experimentally by microorganisms of the paratyphoid and typhoid groups in association with intestinal parasitism and evidence indicates that these agents are responsible for the development of this group of diseases under field conditions. Hemocytoblastosis is a fundamental condition leading to the development of most of the manifestations concerned. Hemocytoblastosis is characterized by the presence of varying numbers of immature and degenerative blood cells in the peripheral circulation and can be diagnosed easily by the examination of blood smears of affected birds. Difficulties experienced in raising hemocytoblastosis-free birds for experimental purposes and the fact that some of the manifestations under consideration frequently occurred in indoor-hen-battery plants led to a study of battery plant methods of rearing and maintaining chickens. Investigations have shown that intestinal parasitism and microorganisms of the paratyphoid and typhoid groups could not be associated with the mortality problem in indoor-hen-battery plants. Experimental data have indicated that indoor-hen-battery mortality and accompanying syndrome are associated with adverse atmospheric conditions as related to inadequate ventilation.

A study of indoor-hen-battery plants indicated that mortality was the most important problem, often ranging from 40 to 60 per cent and being responsible in many instances for a discontinuance of operations. Major mortality occurred as the result of the development of paralysis, leukemia, and chronic hemocytoblastosis. Furthermore, a definite syndrome was associated with mortality: (1) irregular egg clutch, (2) frequent and sometimes more or less continual molting, and (3) poor development of some birds. Blood smears indicated that all birds examined in four battery plants were affected with varying degrees of hemocytoblastosis.

One operator found that recovery occurred when birds showing first indications of illness were removed from the battery room and placed outdoors. A study of four outdoor-hen-battery plants, in which batteries merely were sheltered by a roof, revealed that mortality and the accompanying syndrome occurring in indoor plants existed only in an unusually small degree.

Birds reared under indoor-battery conditions usually do not begin to show indications of manifestations other than hemocytoblastosis until about the age of maturity or any time thereafter. Birds reared outdoors to maturity and then placed in indoor-hen-batteries develop these manifestations, often more readily than birds reared indoors. Young birds raised in poorly ventilated battery equipment were found to develop a greater degree of hemocytoblastosis than birds raised in more open types of batteries, and it is apparent that adequate ventilation is as important to battery equipment as it is to the room which houses this equipment. Birds raised under adverse atmospheric conditions were more susceptible to all types of experimental procedures of inducing fowl paralysis, leukemia, and allied conditions which makes the problem of ventilation of prime concern to research workers conducting investigations on this group of diseases.

Experiments conducted in one indoor-battery experiment extending over a three-year period and in which birds were raised from day-old to 12 months of age indicated a rather definite biologic saturation point for the room in which the experiment was conducted. During the first year 75 day-old chicks were started in this room; at the conclusion of the 12-month period, 42 birds remained. During the second year 41 of 100 birds were living at the end of the 12-month period. During the third year in which only 35 chicks were started, 34 remained at the conclusion of the experiment. Mortality during the first two 12-month periods was similar to that occurring in indoor-hen-battery plants and began to occur when the birds were 5 months of age. There appears to be a rather definite biologic saturation point for every hen battery plant. In case the population exceeds this point, manifestations induced by adverse atmospheric conditions occur. The common practice of replacing birds lost through mortality merely tends to perpetuate the mortality problem. The laws governing the biologic saturation point of chicken populations in battery plants are considered to be similar basically to those determined by numerous workers governing the densities of populations in relation to mortality among fish, insects, and other lower forms of life.

The time factor is important in the absence of mortality in the broiler and fryer plant. However, hemocytoblastosis which is induced in inadequately ventilated broiler and fryer plants leads to at least four very definite consequences: (1) lowered resistance to infection, (2) reduced growth rate, (3) poor feathering, and (4) lack of uniform growth. Mortality often is observed in broiler and fryer plants in which ventilation is grossly inadequate. Thus, the economics of production in such plants is concerned vitally with adequate ventilation. This was strikingly demonstrated by one poultryman who found that the cost of producing a pound of gain increased repeatedly each time the population of his broiler plant was increased. This cost of production decreased to its original level when the owner installed a more adequate ventilating system.

The importance of adequate ventilation in battery plants cannot be stressed too greatly. It would appear that the economic utilization of an indoor-battery plant necessitates some adequate system of forced ventilation. A study is being made of the factors concerned in adverse atmospheric conditions; temperature, humidity, and oxygen-carbon dioxide relations appear to be important at this time.

A study of adequately ventilated plants has indicated that a number of factors are important in the correction of adverse atmospheric conditions. Each plant appears to be a specific problem in itself as environmental conditions surrounding the plant seem to bear some relation to the problem. Most poultrymen build a battery house and think of adequate ventilation later and still other poultrymen must have a certain amount of individuality about their plant which makes its ventilation a difficult problem. One of the most difficult problems is to adequately ventilate a building which has been constructed for purposes other than rearing chickens. Often it is difficult to impress upon the owner

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that the success of an indoor-battery plant is dependent largely upon the installation of an adequate ventilating system and that the decreased cost of production under adequate ventilation will more than compensate for any reasonable sum expended for this purpose.

While a study of the factors favoring adequate ventilation is being continued, certain ones seem to be of paramount importance. In case only an intake or exhaust fan is installed, the intake fan under practical conditions appears more important than the exhaust fan. The intake fan can be directed so as to circulate air in the room more efficiently than an exhaust fan. Exhaust fans often have their efficiency reduced as far as fresh air intake is concerned by being forced to pull foul air through ducts. Fresh air must be continuously supplied and should enter near the ceiling or should be directed towards the ceiling; in the winter the cool air from the outside is mixed with the warm air near the ceiling of the room, while in the summer in southern climates some operators have found it advisable to cool the fresh air by a water-drip system. The ceiling should be high to allow adequate movement of air over the batteries with no draft on the birds. Outlets should be within 18 in of the floor and either extend upward through the wall to the loft and out through ventilators or by means of shafts extending through the ceiling. The location of outlet air shafts depends to a large extent upon the size and shape of the room. The size of the intake fan is dependent upon its location and the size and shape of the room. Birds should not be subjected to drafts from the fan either directly or indirectly. An intake fan of a capacity calculated to change the air in a room every so often cannot be depended upon to furnish adequate ventilation on account of other factors involved. Likewise the maintenance of a constant temperature is insufficient if other factors are not considered.

This brief discussion of some of the factors concerned in adequately ventilating a battery plant gives an indication of the complexity of the problem, yet when each of these factors, as well as others, are given proper consideration, adequate ventilation can be assured at a cost which is not prohibitive to the poultryman who prefers this method of housing chickens.

The Design of Plot Experiments for Measurement of Run-off and Erosion

(Continued from page 432)

manure on run-off and soil loss is influenced by the use of a cover crop. This is the same as the question whether the effect of a cover crop is influenced by the use of manure for the difference, if it exists, involves the two treatments equally. This is known technically as the interaction between cover crop and manure. There are other interactions between the three variables which have been indicated above in the outline of the analysis of results.

Thus in this factorially arranged control plot experiment, not only are the main effects of the three variables measured with the same precision as though the entire experiment had been devoted to each, but the possible interactions between them have been measured with full precision. If a research worker should attempt to answer all of these questions by letting but one factor vary at a time, he would be lost in a maze of experiments.

An estimate of the precision with which the treatment comparisons have been made is based on the variations between plots treated alike with respect to manure and cover crop and of the same length. Since the experiment was run in duplicate, each of the 12 treatment combinations will provide one comparison or degree of freedom for making a pooled estimate of the precision of the experiment. This is the so-called error term shown in the outline.

It is this estimate of error which enables us to make due allowance for random or sampling error when crediting observed effects to the various factors or causes. This relieves the experimenter of a heavy responsibility, for the experiment has furnished not only the differences between treatment variations but also a criterion for drawing conclusions as to the existence of a real or significant effect. This is a feature of all properly designed replicated experiments.

How Much Rent Can a Cow Pay?

(Continued from page 434)

four milking stalls (concrete floor throughout) that can be built to meet health regulations for $20 a cow. That figure does not include silo or hay storage.

It does not necessarily follow that the most economical building is the one that costs the least to build, nor the one which the cow can rent for the lowest figure. With only 6 per cent of a cow's income going for rent, and her income sometimes as low as $80 or $100 a year, there can't be a huge saving if you cut the figure in half. Anywhere from 50 to 80 per cent of a dairy cow's income goes for feed, and anywhere from 20 to 40 per cent for labor. Cut the feed item even one-fifth, and the saving amounts to as much as the whole building item; cut labor item one-third, and the saving is greater than the entire building item.

To put it another way, a dairyman with a herd of big cows, feeding largely on good-quality, home-grown hay and grains, could have a feed cost so low that his building cost, if need be, might run higher. If by chopping his roughage, he can get along with less mow space, his cows can buy more barn for their money when they want to build. If by use of a trench silo he can cut the haymow capacity still more, his barn money will go still farther.

Figures and opinions I have been able to gather from here and there indicate that farm buildings experts have their hands full planning a modern, efficient barn which low or average-producing cows can afford, one that will last, and one that will retain its use value as long as it lasts. (It is possible to put up a building whose use value disappears before the building wears out.)

The head of the farm structures work at one of the leading land-grant institutions told me not long ago that the logical approach is to set up the conditions which a dairy barn should provide and design the structure as economically as possible without losing more on the other factors than he saves in housing. The head of the dairy department at one of the state agricultural colleges remarked: "Usually it is not shelter and equipment that makes the difference between high and low production." A farm management professor at one of the agricultural colleges told me: "Practical experience indicates that the building can be too good, and we have no idea of how poor it can be before it begins to cut in on the efficiency." And a country banker told me: "When a farmer comes to us about a dairy barn, we don't ask him how much money he wants to put into a barn, but how much milk his cows average to produce in a year, and what he spends in a year for feed per cow."

These remarks indicate that the folks who are interested in dairy cow housing are not looking at the subject through the same set of spectacles. Perhaps, in part, that is why, in so many cases, the dairy herd keeps on using one corner of a dilapidated barn instead of setting up housekeeping in a home all its own.

Economic Possibilities of Farm Mechanization

By Dr. R. B. Corbett

ANY ANALYSIS I am able to make indicates that a great and sudden expansion in mechanization—a revolution—in agriculture, is not probable. At the same time I do not feel that the saturation point is within sight. It is my belief that there will be an increasing use of power and machinery on American farms. Certainly most of the evidence is in favor of such a belief. The long-time trend has been upward. While periods in which this trend has been broken will be pointed out, there are good reasons for this upward trend, and there are many reasons to believe that it will continue for some time. The rate of this upward movement, and the breaks in it, will depend upon a number of factors, and I shall try to discuss some of them briefly.

The dominant factor is farm income. There are two ways of substantiating the effect of income on mechanization that leave little doubt as to its importance. One is to compare periods of time in which the income was low with periods when it was relatively high. The other is to compare geographic areas in which incomes are low with other areas where they are high. In periods of time when incomes have been low — in other words, when farmers have little money to spend — the trend toward mechanization has been greatly retarded. The numbers of tractors bought by farmers in the United States gives sufficient evidence. In 1929 this number was 137,000; in 1930, as the depression began to take hold, the number dropped to 116,000; by 1931, when things were severe and few farmers were making net incomes, the number dropped to 58,000; and, in 1932 and 1933 when things were really serious for all of American agriculture, only 25,000 tractors were sold to American farmers. Thus the number dropped to less than one-fifth of what it had been. You will recall that 1936 was a fairly good year, and the number of tractors sold to farmers jumped to 165,000. The following year, the spring of which was probably the best spring we have had since 1929, the number increased to 221,000. Then in 1938 when things were not so rosy and incomes were lower, the sales to farmers decreased to 151,000. In 1939 the number increased to 170,500, and in 1940 to 231,800. Of this last figure 79.8 per cent were general-purpose tractors under 30 hp. To me this is definite proof that sales of tractors go hand in hand with the income on American farms, and what is true of tractors is undoubtedly true of all mechanical equipment.

The other way of proving this point is on a geographical basis. It has been estimated[1], for example, that 75 per cent of the northeastern farms may eventually become electrified, while in the Southeast and South only 25 per cent will become electrified. Figures indicate that the net cash income of northeastern farmers is around $636 per farm, while in the south Atlantic states this figure is around $460, and less in the South. Is there any doubt as to the relationship between the low estimate of possible electrification on the southern farms and the lower income? Also, in New York state, where a survey of 9,574 farms was made, it was found that on 695 farms classed as poor farms with low incomes, there were only 52 per cent of the farms connected to electric lines, while on 1,219 farms classed as excellent, with very good incomes, the percentage of farms connected to electric lines was 98. This is again definite proof that farmers must have good incomes if mechanization is to go forward rapidly.

No apology is necessary for emphasizing the importance of income upon mechanization. There is abundant evidence that too many individuals have made their farm plans without sufficient regard to the possible income. There is still more evidence that "public" (if I may use the word) plans for agriculture have been woefully weak in regard to the realities of farm income. Placing farm income as the first factor affecting the future possibilities of farm mechanization seems to me to be entirely proper.

A second factor affecting the development of farm mechanization is the relative prices of things farmers have to buy as compared with the prices of things farmers have to sell. Of course these price relationships are basic to farm income. In general, when farm prices are at a disadvantage, farm incomes are low. Thus income and price relationships are closely interwoven. Low income prevents the farmer from purchasing a new tractor, and price disparity may cause him to leave a tractor he already owns in the tool shed, and use horses. If gasoline, oil, and parts are high compared with the prices he can get for his grain, he may decide to feed the grain and not make the costly outlays for maintaining the tractor. While it is difficult to get statistical evidence, many farmers were reported to have made this decision in the worst years of the depression.

The trend toward mechanization is apt to increase rapidly in the period just ahead. There seems little doubt that unless prices are rigidly controlled, there will be higher prices than there have been for many years, and an unusual demand for all kinds of production. In periods of rapidly rising prices, farm prices and farm income have always been unusually good. We are in such a period now. A quotation from a statement made during the Civil War is applicable to conditions today: "That without horse rakes, mowers, and reaping machines one-half of the crops would have been left standing in the fields * * *". From another source: "The Civil War furnished the supreme test of the worth of the reaper. By taking the place of regiments of young men in western harvest fields, it released them to do battle for the Union at the front and at the same time kept up the supply of bread for the nation and the nation's armies. Thus, without McCormick's invention, I fear the North could not have won, and the Union would have been dismembered."

This same demand for men to carry on the defense of this country, and to continue to furnish food supplies exists today as is described in these quotations on the Civil War. There are only two things which will retard an extremely rapid trend toward mechanization in the months just ahead, one is rigid price fixing at low levels and the other is the difficulty of obtaining the materials to make the machines wanted. With farm labor so scarce that all farmers are complaining, and with the increased demand for farm products both to feed this nation and to help feed the other democracies of the world, there is little doubt that farmers will demand labor-saving equipment as rapidly as it can be made. Thus I would expect the work of the agricultural

Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers at Jackson's Mill, W. Va., October 1941. Author: Director, Maryland Agricultural Experiment Station.

[1]Pinches, H. E., Journal of Farm Economics, vol. 20, no. 1, February 1938, p. 372.

engineer to increase by leaps and bounds during this war period, if farmers are able to obtain the equipment. If not, the work of the agricultural engineer will increase because of the demand for knowledge on how to maintain old equipment in good repair including the replacement of old parts with new.

A third important factor affecting mechanization of American farms is the size of farms. If you will tell me the trend in the size of farms in this country, I can give you a much better forecast on the rate of mechanization in the future. The automobile has made nearby farming sections available to city workers as homes. Part-time farmers can not operate a large farm business. Thus their farming alone is bound to bring in a small income, which, however, coupled with their city income is a real help to their standard of living. As an area moves toward this type of farming, it would appear that rate of mechanization is retarded.

Size of farm is one of the most important factors in good farm income, and in efficient use of farm machinery. Data from Cornell University show that the average tractor on farms keeping cost accounts in New York state in 1939-1940, was used 469 hr per year, and the cost was 49c per hr. The tractors that were used for 600 hr per year had an average cost of only 38c per hr, and those that were used only 200 to 300 hr per year had a cost almost double that of the tractors that were used the most. If a farm is so small that there is only a few hours of tractor work per year, the cost is exorbitant.

THE RATE OF MECHANIZATION MUST KEEP IN LINE WITH COSTS OF PRODUCTION

In this connection the effect upon mechanization of programs to develop four or five-acre farmsteads might well be considered. Several of these experiments are being conducted in West Virginia. Also, the purchase of small farms through the tenant purchase program will effect the trend toward mechanization. In reasonably good times in good farm areas, there has usually been a trend toward larger farms, the little farm selling out to its neighbors. The larger businesses resulting are more efficient and can use mechanical equipment to greater advantage. With anything like reasonable economic conditions, this trend should continue, and with it the trend toward more mechanical equipment. If, however, those that believe there will never be a return to good farm incomes are correct, and if those who hold that we should plan for small self-sufficient farms of the European-peasant type are right, then all that has been said about a continuing long time trend toward mechanization is incorrect and wrong.

A fourth important factor in the rate of mechanization is its high costs. Personally I do not feel that we study costs as carefully as we should. Too many economists arrive at the conclusion that cost of production has nothing to do with prices except over long periods. They are impressed with the fact that costs of production vary greatly under different circumstances and conditions and that "average costs" have little meaning. They then arrive at the conclusion that there is little point in studying costs. I have seen many projects undertaken in the last few years which have turned out to be of little help to anyone. In many cases a study of the costs involved and the incomes available would have saved the mistakes that were made. I know of no better way of keeping one's feet on the ground than to figure the costs involved in any undertaking under consideration. For example, I believe there has been some very optimistic thinking about rural electrification in this country. An estimate[2] of the absolute minimum for a family to become a user of electricity is $210, $69 for wiring and $141 for appliances. Usually, I believe, an agricultural engineer will state this figure considerably higher than $210.

If the total amount of money that the average farmer in the United States has to spend during a year is $552, and out of this he must buy what food he does not raise on the farm, the clothes for his family, any amusements that the family may have, all the doctors' bills, any costs for education, certainly there cannot be too much left for farm improvements. If it is going to take approximately 40 per cent of a year's income, rural electrification is going to move slowly. I question seriously if the nation is going to continue its subsidy for developing rural electric lines. If this is true, then rural electrification is going to progress only as rapidly as farm income allows it to progress. The costs of electrification in relation to farm income are too high for rapid expansion in most parts of the country.

EXPENSIVE, SUPERFLUOUS GADGETS HAVE RETARDED THE PROGRESS OF MECHANIZATION

One of the things that has retarded mechanization in this country has been the high cost of the superfluous gadgets which are placed on many forms of equipment. This is more true of home appliances than it is of farm appliances. A specific illustration which is weak because the cost is not added by the manufacturer, but which definitely drives home the point, has recently come to our attention at the University of Maryland. Mr. Burkhardt and the other men in our agricultural engineering department, in cooperation with the dairy department, have developed a small milk pasteurizer. One that will do a job with only a few gallons of milk. It was our hope to make this available to farmers at around $150. Think what the possibilities of this are when city after city and even village after village is requiring that all milk be pasteurized. The present equipment is so costly that only large handlers of milk can afford it. It has recently been found that practically all of the milk regulations on pasteurization require a recording thermometer that in itself costs $150. Here one might say is a gadget that costs as much as the equipment itself. Let's not go into the merits of this requirement, but let's remember that expensive gadgets retard the use of mechanical equipment.

While we are on the subject of costs, some figures from the cost accounts in New York state are quite illuminating. The cost of keeping a horse and maintaining his harness throughout the year on these farms was $133. The cost of the average tractor operation on these same farms was $227.48. A horse was used 698 hr in the year, while a tractor was used only 469 hr. This means that the cost per hour of horse work was 19c, while that of the tractor was 49c. The cost of a team of horses was $266 as compared with $227.48 for the tractor. And, on the larger number of hours worked, the cost per hour for a team was 38c as compared with 49c for the tractor. This, however, does not give the whole picture because the tractor will plow many more acres in a given period of time than the team of horses. The cost per acre for plowing with a tractor was $2.10, while the cost per acre of plowing with a team was $4.73. There seems to be little doubt about the efficiency of the tractor on reasonably large farms. This does not take into consideration the important factor of getting the work done on time. This is true of much of our mechanical equipment. Farmers will purchase it as rapidly as economic conditions and their incomes allow.

A fifth point influencing the economic possibilities of farm mechanization is one familiar to all. Improvements

[2]Pinches, H. E., Journal of Farm Economics, vol. 20, no. 1, February 1938, p. 380.

that allow a machine to do more and better work without excessive increases in cost will greatly speed the trend toward mechanization. Improvements that lower the cost alone will have somewhat the same effect. This point is well illustrated in some of the developments with tractors and their attachments. This field is a constant challenge and opportunity to the agricultural engineer. Also in this connection, the chemurgic movement may bring new developments in farm machinery that will hasten the mechanization on farms. This, however, is not clear at present and little other than pure conjecture can be said.

In summary, I believe the trend toward greater mechanization will continue. If this is not true, then let us expect our American agriculture to become more and more like that of the European peasant. This trend over a long period of years will not be steady. There will be periods when it will increase rapidly and other periods when mechanization will seem to be disappearing from the farms. These periods of sharp increase and decrease will be closely associated with periods of sharp increase and decrease in farm income. The trend in the size of farms in the country will affect the rapidity of mechanization and the possibilities of agricultural engineering generally. Small part-time farmers will never become great users of mechanized equipment. Large efficient commercial farms will use increasing amounts of mechanized equipment if their incomes can remain reasonably good. Improvements in equipment that will allow a better job at lower costs will increase the use of power and machines.

Finally, the agricultural engineer will have an increasing job in the period just ahead. With great demands for supplies of food and feed, and with higher prices, mechanization will go forward rapidly if the equipment can be purchased. If it cannot, the agricultural engineer will have his hands full in helping farmers to make their present equipment last longer.

Electric Light in Insect and Bacteria Control

YOUR committee notes a paper by Dr. F. R. Smith and Dr. Harry Stierli of the University of California, presented at the Rural Electrification Conference in January 1941, entitled "The Use of Ultraviolet Light for Sterilizing", which reports on the following:

(1) *Germicidal Lamps for Hydro-Cooler Water*: To cool vegetables before putting them in refrigerator cars for shipment. Cooled by running cold water over them. This might spread infection throughout the lot. It was possible to kill with a laboratory setup 90 per cent of one type of bacteria, *Serratia marcescens,* in water as cold as 35 F by passing the water through a 4-in pipe with a 15-w germicidal lamp on the pipe axis. It was found that the killing effect became much slower as the temperature of the water was lowered. Lamp efficiency and life were materially reduced at hydro-cooler temperatures 35 F when the lamp was immersed. In two commercial installations using germicidal lamps above the water no appreciable effect could be obtained. Even with an immersed heat insulated lamp no significant reduction in bacteria or mold could be detected.

(2) *Control of Mold in Condenser Water.* An evaporative condenser in a refrigeration system located in a basement developed trouble by the accumulation of slime (identified to contain a mold, apparently *Mucor adventitious,* and a bacteria, *Flavobacterium ovale*). A 15-w germicidal lamp hung about 8 in above the sump and 6 to 8 in from the drip successfully allayed the development of further mold or bacteria, and upon the removal of the slime completely prevented its reformation.

Mold in Greenhouses. Prof. Kenneth Post, at Cornell University, tried germicidal lamps in a greenhouse to control damping off and the growth of surface molds. He was unable to control such things with less than one hour's exposure to a bare 15-w germicidal lamp at 2 ft. Such exposure caused serious injury to the plants.

Lighted Insect Traps. T. E. Hienton, Purdue University, reports that they have continued their tests on the control of corn borers and are perfecting the type of trap and method of use to eliminate the circling effect of moths after they have been attracted by the lamp.

Killing Bacteria. Dr. H. C. Rentschler, of the Westinghouse Lamp Division, reports that his research has proven the Bunsen-Roscoe Reciprocity Law, which says essentially that time of exposure times intensity is a constant, applies to lethal dosages of germicidal radiation on bacteria over a very wide range, i.e., from intensities requiring only a few micro-seconds up to 30-hr exposures. He also shows that the susceptibility of bacteria to ultraviolet radiation varies at different periods in their life cycle. He concludes that it is therefore better to use low intensity for a long period to take advantage of the sensitive period in the life cycle of the bacterium.

Germicidal Radiation. Your committee is convinced that far ultraviolet, or germicidal radiation, is about to play a major roll in the control of bacteria, particularly airborne bacteria, making it practical for the first time to sterilize large volumes of air at relatively low cost.

Lamps that Attract Fewest Insects. Experiments to determine the color of light which is least attractive to insects were reported in the June issue of the "General Electric Review". The conclusions state that (1) there is no such thing as light which will not attract any insects; (2) that red light attracts the fewest numbers of insects but is not a practical work light. Yellow is a good compromise unless pleasing color values are essential, in which case flame-tint lamps are recommended. (3) On an equal brightness basis, colored lamps lose much of their advantage as far as attracting the fewest insects is concerned. (4) The most effective way to reduce the number of insects attracted is to use low-wattage lamps.

Black Light. We note a steadily increasing use of black light to detect diseased products, such as seed potatoes, moldy grain, etc. While black light is not used to directly control such things, by enabling their detection, indirect control of their spread is considerably advanced.

Purple X Lamp. During the past year a new source of black light, known as the Purple X lamp, has been made available by the Mazda lamp manufacturers. This is a 250-w black bulb lamp that will operate directly on the lighting circuit, either a-c or d-c, without the use of transformer or other form of ballast. While the lamp is not nearly so powerful as the mercury arc, its simplicity and low cost will undoubtedly result in a much wider use of black light than heretofore.—Contribution of the A.S.A.E. Committee on the Use of Electric Light for Insect and Bacteria Control:

J. M. Fore, H. B. Herms, T. E. Hienton,
L. R. Koller, W. L. Mallmann, B. D. Moses,
M. W. Nixon, H. C. Rentschler, L. C. Porter,
(chairman)

Applying Fertilizer in Liquid Form

By Dr. Victor A. Tiedjens

APPLYING fertilizer in liquid form is another cultural practice adopted by commercial growers and small gardeners that had its origin as a research tool in studying the availability of fertilizers for crops. Fertilizer dissolved in water for application to growing crops has an appeal to the plantsman and has been adopted because of its many seeming advantages by both commercial growers and small gardeners.

We add fertilizer to the soil to supplement the plant food present, with the expectation of producing larger yields of higher quality food. We know from research work that before chemical fertilizers are of any use to plants, they must be dissolved in the soil water. In this way they find their way into the roots of plants where they are manufactured into the various products of the plant. It would seem, therefore, that the efficiency of dry fertilizers for crop production depended on the moisture content of the soil. Unless we can be assured that the fertilizer will be dissolved it may not do us any good. Therefore, it would seem that if this fertilizer could be dissolved in water before it is applied to the soil, there would be a much greater chance that it would reach the roots. Observations indicate that fertilizers applied in the liquid form are more quickly available than when applied dry. Growers have claimed that their plants fed with liquid fertilizer have grown faster in dry weather than those fed dry fertilizer. Apparently there was less chance for salt concentrations to interfere with water absorption by the plant.

Another advantage which seems evident from research is the greater availability of phosphate salts when applied in the liquid than when applied in the dry form. Phosphates as a rule are not as soluble as nitrate and potash salts, and therefore we apply more phosphates in dry fertilizer than are necessary to supply the needs of the plant. This is not necessary with liquid fertilizer and accounts for the fact that we do not use as much fertilizer. Some growers claim the use of liquid fertilizer will gradually deplete the soil. Experience has not supported this contention. As a matter of fact, what observations have been made show that crops following those which were grown with liquid fertilizer have made more growth than those following crops supplied with dry fertilizer. After all, we can grow a plant in pure sand with much less fertilizer than it takes to grow the same plant in soil supplied with dry fertilizer. This would indicate greater efficiency for the liquid than dry fertilizer. In any good soil we have enough plant food made available every year through such agencies as climate and soil flora to grow fair to good plants. In our fertilizer practices our plan is to add sufficient fertilizer to the supply in the soil to satisfy the needs of the growing crop. Anything beyond this may be wasted. We put on an excess because we cannot judge the quantity that we need with sufficient accuracy. This is a necessarily wasteful practice. Later side dressings of dry fertilizers do not always produce the desired effect. Applying the fertilizer in solution gives immediate results and makes it possible to apply small quantities of fertilizer as needed. Therefore, we get as good results with smaller quantities of fertilizer when applied in liquid form.

Applying fertilizer in liquid form makes it possible to put on a much wider variety of materials. It is difficult to apply small quantities of sticky fertilizer in the dry form. These materials can be applied when dissolved in liquid form in quantities as low as 10 lb per acre at an extremely uniform rate.

Expensive machinery is not necessary for ordinary purposes. The liquid can be applied by gravity from a tank mounted on a cultivator or tractor. Most growers can build their own equipment.

There is no danger of burning the plants because high concentrations of fertilizer are not used. In many cases where dry fertilizer is applied in liberal quantities too close to the plants, there may be injury so that little good is obtained from the material applied. When liquid fertilizer is applied, there is much less chance for injury.

Thus, there are quite a number of advantages attendant to the application of fertilizers in the liquid form.

How then does the liquid method differ from the dry method? The application of liquid fertilizer starts when the seedling is set or the seed is planted. For this purpose, the first essential is a mixed fertilizer that is completely soluble. This means a mixture of nitrogenous, phosphate and potassium salts. Because of the nature of the soluble salts a high analysis fertilizer is a necessity, so we use a 13-26-13 mixture. One to three pounds of this mixture are dissolved in 50 gal of water and ¼ to ½ pint is applied to each plant. Two to three times this concentration may be applied directly to the seed as it is planted at the rate of ¼ to ½ pint per foot of row.

After the plants are established, they are side-dressed with a solution containing from 3 to 10 lb of the mixture in 50 gal of water. From 200 to 400 gal are applied to an acre. From one to three applications should be applied as the plants develop and the application should be made just at the edges of the leaves so that by the time the applications have all been made the fertilizer is well distributed in the soil between the rows.

There are certain precautions that must be observed in using liquid fertilizers. Because of the necessity of using water-soluble salts, mixtures are used which do not contain much calcium and magnesium and which tend to make the soil acid. For this reason pulverized limestone should be used freely where liquid fertilizers are used. Liquid fertilizer, like dry fertilizer, does not give efficient results unless the soil is of a limestone origin or is sweetened with frequent applications of pulverized limestone.

Starter solutions applied to plants consist of comparatively small quantities of fertilizer dissolved in water. Experimental results show that yields of sweet potatoes have been doubled (75 to 150 bu) by merely adding 20 lb of a 13-26-13 fertilizer to the acre. Yet if this starter solution is added to plants where 500 to 1000 lb of dry fertilizer have been applied along the row, it will have no effect or may even reduce the yield. This simply means that if a small quantity is enough, more may cause injury and reduce rather than increase yields. In other words, if an acre of tomatoes requires 100 lb of nitrogen, 35 lb of phosphoric acid, and 150 lb of potash, *(Continued on page 442)*

Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers at Jackson's Mill, W. Va., September 1941. Author: Associate olericulturist, New Jersey Agricultural Experiment Station.

Another Agricultural Engineering Milestone

By Walter B. Jones
MEMBER A.S.A.E.

AGRICULTURAL engineering advanced to new recognition in the academic world on October 11, when Rutgers University conferred on Robert William Trullinger (Fellow A.S.A.E.) the honorary degree of Doctor of Engineering. It was a notable occasion, not only in the stature of the small group to whom degrees were awarded, but in being the 175th anniversary celebration of the founding of the University.

Doctorates, especially those of science and philosophy, are no novelty in the ranks of the American Society of Agricultural Engineers. But, so far as can now be recalled, this is the first time the rarer degree in engineering has come to any Society member, save only the award in 1933 by the University of Nebraska to the conceded dean of the profession, J. B. Davidson.

DR. ROBERT W. TRULLINGER

Among the fifteen doctorates conferred by Rutgers on this occasion, only two were in engineering. The other candidate was Karl Taylor Compton, past-president of the American Society for the Advancement of Science and since 1930 president of the Massachusetts Institute of Technology. On the afternoon of October 9 he presided over the session at which Mr. Trullinger presented his paper in an anniversary symposium, and earlier the same day he delivered one of the anniversary lectures.

Also appearing in the series of lectures and symposia were the three candidates for doctorates in science, namely, Irving Langmuir, famous for his discoveries and inventions during his thirty-two years as scientist for the General Electric Company; Ernest Orlando Lawrence, director of the radiation laboratory at the University of California and inventor of the cyclotron; and Hugh Scott Taylor, for fifteen years chairman of the department of chemistry at Princeton University and famous as an authority on physical chemistry.

Mr. Trullinger's paper was entitled "The Case for Agricultural Engineering." The other paper in the same symposium was by Vannevar Bush, president of the Carnegie Institution of Washington, who discussed a closely kindred field under the title, "The Case for Biological Engineering." It was read in absentia by Dr. John W. Bunker, director of the graduate school of the Massachusetts Institute of Technology.

That our "Bob" was honored primarily for his prominence in agricultural engineering, also for his vision and vigor in promoting real research, is apparent from the notations under his name in the convocation program, which listed him as: "Graduate of Iowa State College; since 1912, agricultural engineer in the Office of Experiment Stations, U. S. Department of Agriculture; since 1912, editor for agricultural engineering of the "Experiment Station Record"; expert on the organization and methodology of engineering research; past-president of the American Society of Agricultural Engineers; assistant chief of the Office of Experiment Stations."

Conferment of this degree also reflects honor on another of our veteran members, E. R. Gross, head of the

In this group are the recipients of the honorary degrees awarded by Rutgers University at the 175th anniversary celebration of its founding held in October. Left to right, William H. S. Demarest, Wendell L. Willkie, Robert W. Trullinger, Hugh Scott Taylor, Roscoe Pound, Rhys Carpenter, Roy F. Nichols, Charles H. McIlwain, Clement C. Williams, Clarence Dykstra, Karl T. Compton, Roy Harris, Robert C. Clothier (president of Rutgers University), Alexander Louden (minister of the Netherlands who, in her absence, received the degree conferred upon Queen Wilhelmina), Ernest O. Lawrence, and Irving Langmuir. Fifteen honorary degrees were awarded on this occasion

Rutgers University department of agricultural engineering. Though Rutgers ranks high in the caliber of its agricultural engineering work, the state of New Jersey is small, agriculturally speaking, and Mr. Gross's department is likewise small in relation to the other parts of the institution. Its representation among the honorary degrees thus becomes all the more significant, especially as the candidacy of Dr. Trullinger originated elsewhere in the university.

Because Dr. Trullinger's career has been reviewed so recently in these pages (AGRICULTURAL ENGINEERING for February 1941) in connection with the Society's award to him in June of the John Deere Gold Medal for "distinguished achievement in the application of science and art to the soil", it would be redundant to repeat it at this time.

In the course of his paper Dr. Trullinger said: "One may well raise the question as to why there is need for the agricultural engineer when there are so many other kinds of engineers available whose techniques are used by agricultural engineers. From what has been said, it might be inferred that agricultural engineering is merely the application of a broad category of engineering principles to agricultural practices. Theoretically this may be true, but it is not quite that simple in fact. . . . . .

"From its beginning as a technical profession agricultural engineering has therefore perhaps been somewhat unorthodox in some respects. For instance, the average structural engineer would not countenance the design or erection of a statically indeterminate structure. The agricultural engineer who first encountered one probably did not like the idea either, but the needs of hay and crop storage, as well as the existence of certain difficult precedents and traditions, forced him to accept it until he could provide something better. In fact, there were existing farm structures of this character built by skilled artisans with obvious disregard for structural economics but which had stood the test and stress of time, weather, and service fairly well. The agricultural engineer simply gulped and added a few members at the right places so that the structure fitted the laws of graphic statics, and thereby saved his face and the faces of a lot of structural engineers. So far as I can learn no members were ever subtracted. . . . . .

"The development of the modern plow, for example, required the evolution of entirely new dynamic principles which consider the soil as well as the machine and recognize that the need of the crop plant for certain tilth conditions is the governing factor in the design of tillage machinery. Agricultural engineers have therefore come to know that the soil is not an inert body but is alive and dynamic and capable of dynamic reactions which just must be recognized, controlled, and properly manipulated if the forces within crop plants are to be likewise controlled and directed in the interests of mankind. . . . . .

"Recognizing the fact that a specialist in any profession can best serve an industry if he knows something about that industry and its needs for his special brand of scientific service, many of these land-grant institutions are attempting to train young men so that they will acquire a general knowledge of the fundamental sciences of agriculture as well as an intimate knowledge of the basic principles of engineering. This is done in various ways according to the educational facilities available, but one of the most popular and obviously practicable methods is to have the agricultural engineering curriculum administered jointly by the colleges of agriculture and of engineering."

Although outside the domain of science and engineering, it is of interest to note some of the notable personages who received the degree of doctor of laws and who thereby were Dr. Trullinger's colleagues for the memorable occasion. Among them were Roscoe Pound, famous alike in law and in botany as author, administrator, and educator; Clarence Dykstra, distinguished for achievement as city manager of Cincinnati, as president of the University of Wisconsin, as first director of Selective Service, and first director of the National Defense Mediation Board; Wendell L. Willkie; and Queen Wilhelmina of The Netherlands.

EDITOR'S NOTE: The complete text of Dr. Trullinger's paper, entitled "The Case for Agricultural Engineering", presented on the occasion of his receiving the honorary degree of doctor of engineering, will be published in AGRICULTURAL ENGINEERING when a release is obtained from Rutgers University.

Applying Fertilizer in Liquid Form

(Continued from page 440)

and the soil supplied two-thirds of this, there is no reason for adding all that plant food as long as we can supply it in a readily available form. One or two hundred pounds of a 13-26-13 fertilizer may supply enough plant food to make it possible to produce as large a yield as the particular season will permit, even though we have not added the total amount of fertilizer required. There are some years when growers receive much greater returns from their fertilizer than others because of distribution of rainfall and prevailing temperatures. Thus, any quickly available material that can be applied to feed the plants as they need it will be much more economical to use.

Liquid fertilizer appeals to the home gardener because he can fertilize his plants without danger of burning as he waters his plants. It has been used successfully for fertilizing lawns, flower and vegetable gardens, trees and shrubs. For lawns attachments to the spigot are used to suck the solution into the line as the lawn is watered. In gardens this is done with sprinkling cans or long-spouted pot watering cans.

Commercial growers have used liquid fertilizer to their advantage because they say it saves them money. One grower grew 20 acres of tomatoes in 1940 and cut his fertilizer cost in half. He produced over 10 tons of tomatoes per acre, almost double the state average yield. Another grew 30 acres of tomatoes in 1941 with 164 lb of fertilizer per acre and picked over 10 tons. One asparagus grower has grown 50 acres of asparagus for three years with liquid fertilizer at a saving of $18.00 per acre over dry fertilizer. I have received letters from people in practically every state and various places in Canada asking for detailed information. I have yet to receive a discouraging note from a grower who has tried liquid fertilizer. I know that eventually I will because people do not pay attention to directions. One grower wrote me a testimonial that made me think of liquid fertilizer as a patent medicine: "I tried liquid fertilizer this year and it put me on my feet." Obviously he meant financially rather than physically, although worry over poor yields and high production costs probably has gotten many a grower into difficulty.

The machinery people have not done much work in equipping farm machines for applying liquid fertilizer; apparently there has not been a sufficient market for such equipment to justify it. As a result growers have built their own. Barrels mounted on tractors and old automobile gasoline tanks mounted on cultivators are common equipment. Some growers apply the liquid with their sprayers by removing the nozzles. Any equipment that will put on a half-inch stream of water on either side of the plants just at the edge of the leaves serves the purpose, *if* the soil is moist. If the soil is *dry*, the liquid should make contact with moist soil. This is accomplished by placing the outlet tube just in back of the cultivator teeth.

TRADING CHAPARRAL FOR RHODES GRASS!

"Caterpillar" Diesel Tractors, equipped with tree-dozers, have cleared the mesquite, ebony wood, cactus and other growth from 60,000 acres of land, for the King Ranch in South Texas. (Note "Running W" on D8).

The Diesel D8, for example, with its 113 horsepower harnessed by positive traction, clears about two acres of such brush-growth per hour—at a small fraction of former grubbing expense.

Clearing, and seeding this land to Rhodes grass, increases its value for pasturage 500%, or more! Herds of the noted Santa Gertrudis breed of cattle, which this ranch developed, are thriving on pasture so reclaimed.

And many another rancher, in Texas and elsewhere, is improving pasture land by this same method of clearing—often opening the way for native grasses to reestablish themselves.

CATERPILLAR

REG. U. S. PAT. OFF.

DIESEL TERRACERS
DIESEL ENGINES
TRACK-TYPE TRACTORS

ON DEFENSE

★ Since New Year's Day, 1941, "Caterpillar" Diesel Tractors have moved more than enough earth to build 2 Panama Canals, on vital defense projects!

NEWS

A.S.A.E. Meetings Calendar

January 14 - 15—Pacific Coast Section, Davis, Calif.
February 4 - 6—Southern Section, Gayoso Hotel, Memphis, Tenn.
April 3 - 4—Southwest Section, Texarkana, Texas.
June 29 - July 1—Annual Meeting, Hotel Schroeder, Milwaukee.

Volume Index to *Agricultural Engineering*

WITH each copy of this issue of AGRICULTURAL ENGINEERING, when mailed to A.S.A.E. members and non-member subscribers, is included a copy of the title page and index for Volume 22, January to December 1941, inclusive. Members and other subscribers to the Journal are requested to check to see that the index is enclosed with their copies, and to report promptly to the Secretary A.S.A.E., St. Joseph, Michigan, in case it is missing.

A.S.A.E. Meetings

Fall Meeting at Chicago. During the three-day period, December 1 to 3, the American Society of Agricultural Engineers held one of its most successful Fall Meetings at the Stevens Hotel, Chicago. There was a registered attendance in excess of 400, which is practically equal to the attendance of any previous Fall Meeting.

Departing from the practice followed in the arrangement of division sessions in recent years, programs featuring subjects under the four main subdivisions of agricultural engineering—Power and Machinery, Rural Electrification, Farm Structures, and Soil and Water Conservation — were spread over the three-day period. This arrangement of the meetings sessions seemed to meet with general approval of those present, so much so in fact that it is planned to follow the same arrangement at the meeting a year hence.

There also seemed to be general approval of the three-day meeting in preference to the four-day meeting of recent years, and because of this the Council during one of its sessions at Chicago decided to limit the length of the 1942 annual meeting to three days.

1942 Annual Meeting. The 1942 Annual Meeting to be held at the Schroeder Hotel, Milwaukee, in June, was originally scheduled for the week beginning Sunday, June 21, but due to conflict with an unusually large convention to be held on the same dates in Milwaukee, the Council of the Society decided to change the date of the meeting to the following week, namely, the week beginning Sunday, June 28. While the usual premeeting get-together and entertainment is scheduled to be held the afternoon and evening of Sunday, June 28, the meeting proper will begin the following day and will be confined to the three-day period, June 29 to July 1, inclusive.

1943 Annual Meeting. The Council of the Society at its meeting in Chicago on November 30, voted to hold the 1943 annual meeting at Purdue University during the month of June. The dates of the meeting have not been definitely decided, but will be either the third or fourth week in June.

Pacific Coast Section Meeting. The Pacific Coast Section of the American Society of Agricultural Engineers will hold its next meeting at Davis, California, on January 15 and 16. All members of the Society residing in the territory of that Section or who may be in that area, will find it well worth while to attend the meeting. A program of the meeting will shortly be announced.

Southern Section Meeting. The Southern Section of the Society will hold its meeting in conjunction with the annual convention of the Southern Agricultural Workers Association at Memphis, Tennessee, February 4 to 6, 1942. The meeting sessions will be held at the Gayoso Hotel. Southern Section meetings are worth going a long way to attend.

Southwest Section Meeting. The Southwest Section of the Society will hold a meeting April 3 and 4, 1942, at Texarkana, Texas. This Section became active again earlier this year and held an excellent meeting at Dallas in April. Doubtless it will have a particularly outstanding program to offer.

Members of the Society who are unable to attend national meetings, will do well to make a special effort to attend the section meetings, all of which are eminently worth while because of the fine programs offered and the other advantages offered by attendance at meetings.

Personals of A.S.A.E. Members

George E. Cubberly is now assistant soil conservationist with the U. S. Soil Conservation Service, and is located at Petersburg, Virginia.

Robert M. Dill has been transferred from the S.C.S. Flood Control Survey work in Kansas to the Upper Leon Soil Conservation District at Rising Star, Tex., where he now has the rating of junior agricultural engineer.

F. C. Fenton, professor of agricultural engineering, Kansas State College, is author of Bulletin No. 41, entitled "The Use of Earth as a Building Material," recently issued by the Kansas Engineering Experiment Station.

Herman Finkel, a 1940 graduate in agricultural engineering of the University of Illinois, is now employed as a dairy farm inspector by the division of health, City of St. Louis, Mo.

Hagen S. Glenn has been appointed rural electrification specialist, Georgia Agricultural Extension Service, and is located at Athens, Georgia.

Hubert T. Heigele has accepted appointment as assistant agricultural engineer, Range Development Service, U. S. Department of the Interior, and is located at Portland, Ore. Until his appointment he was junior agricultural engineer in the U. S. Soil Conservation Service.

Keith Hinchcliff has resigned as instructor in agricultural engineering at the University of Arkansas to take up work in farm structures with the Mississippi Agricultural Extension Service.

Paul R. Hoff, extension agricultural engineer, Cornell University, is one of the authors of Cornell Extension Bulletin 464, entitled "Diversion Terraces and Contour Strip Cropping".

Fred C. Leroux has resigned as graduate assistant in agricultural engineering, University of Missouri, to accept a position as agricultural engineering specialist with the British Columbia Plywood, Ltd., Vancouver, B. C. He will be engaged in promoting the use of plywood for farm building and industrial purposes.

Thomas E. Long, assistant agricultural engineer, North Dakota Agricultural Experiment Station, and *Myron G. Cropsey,* junior agricultural engineer, Bureau of Agricultural Chemistry and Engineering, U.S.D.A., are joint authors of Bulletin No. 302, entitled "Grain Storage on the Farm," recently issued by the North Dakota Station.

Gordon W. Matson, a 1941 graduate in agricultural engineering of the North Dakota Agricultural College, recently accepted appointment as junior soil conservationist (engineer), U. S. Soil Conservation Service, and is located at Roy, Montana.

Earle K. Rambo has resigned as assistant professor of agricultural engineering at the University of Tennessee, to accept the position of extension agricultural engineer at the University of Arkansas.

June Roberts, formerly instructor in agricultural engineering, Kansas State College, and now C.R.E.A. investigator, State College of Washington, and *George H. Larson,* a graduate research assistant in agricultural engineering, Kansas State College, are joint authors of Bulletin 295, entitled "Milk Cooling on Kansas Farms," recently issued by the Kansas Agricultural Experiment Station.

J. Roberts, investigator, farm electricity, Washington Agricultural Experiment Station, is one of the joint authors of bulletin No. 403, entitled "A Comparison of Wet and Dry Cooling of Dressed Poultry," recently issued by that station.

Reuben O. Schlegelmilch has resigned his position with Babson Bros., of Chicago, to accept appointment as assistant in agricultural engineering at the University of Illinois.

J. Merle Trummel has resigned his position in the experimental department of John Deere Plow Works, to accept appointment as instructor in mechanical engineering at the University of Iowa, Iowa City.

(Continued on page 446)

~~80 MILLION~~
~~90 MILLION~~
~~100 MILLION~~
~~110 MILLION~~
~~125 MILLION~~
150 MILLION

It's hard to say just what the figure is today—

The Trend is Growing So Fast!

Just over a year ago, the figure of "50 million used" indicated an unmistakable trend toward Atlas Manasite Detonators. Faster and faster the total has grown. Production has increased constantly to meet the demand. 80 million, 100 million, and now well over 125 million Atlas Manasite Detonators offer conclusive proof of the growing recognition of Atlas Manasite advantages: *greater safety plus dependable action.*

Atlas Manasite Detonators make safety precautions not less important—but more effective. Yet they cost no more. Are you using this contribution toward safer blasting?

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"Everything for Blasting"

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Personals of A.S.A.E. Members

(Continued from page 444)

Homer D. Witzel has resigned as agricultural engineer of the Yale Brothers Manufacturing Company to accept a similar position with Oliver Farm Equipment Company. He will be located at the company's Battle Creek, Michigan, plant and will be engaged in design work on hay tools.

John C. Wooley, professor of agricultural engineering, and head of the department, University of Missouri, is author of a new book, entitled "Farm Buildings", recently published by McGraw-Hill Book Company, New York.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Carl E. Carlson, draftsman, Allis-Chalmers Mfg. Co., LaPorte, Ind. (Mail) 122 South Ave.

J. W. Evans, district rural supervisor, Farm Security Administration, U. S. Department of Agriculture. (Mail) Box 38, Weslaco, Tex.

Edward A. Johnson, assistant engineering aide, department of forestry relations, Tennessee Valley Authority. (Mail) Box 451, Copperhill, Tenn.

John W. Leach, technical engineer, Imperial Oil, Ltd., Winnipeg, Man., Canada.

James Lyon, assistant manager, Lyon Rural Electric Co., San Diego, Calif. (Mail) 2922 Qualtrough St.

James H. Walsh, area construction supervisor, Federal Security Agency, National Youth Administration for North Carolina. (Mail) Box 23, Greenville, N. C.

Marty Ward, manager, manufacturing division, Coop. G.L.F. Farm Supplies, Oneida, N. Y. (Mail) 341 Stone St.

John H. Wessman, student, executive training course, International Harvester Co. (Mail) 431 E. Wayne St., Fort Wayne, Ind.

George Yamanaga, assistant agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 1572 Kalakaua Ave., Honolulu, T. H.

TRANSFER OF GRADE

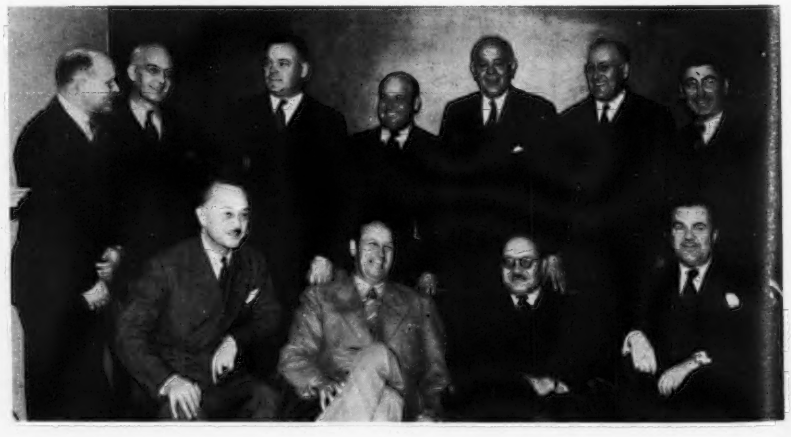
James W. Martin, assistant professor, agricultural engineering department, Kansas State College, Manhattan, Kans. (Mail) 1429 Laramie.

Ag Engineers Have Hand in Inspection Tour

DURING a recent visit to the United States to study agricultural conditions in this country, Senor Marte Gomez, secretary of agriculture of Mexico, made a special trip to the University of Wisconsin to see the new experimental dairy barn and other agricultural-engineering attractions at the University.

Two agricultural engineers, and members of A.S.A.E., "engineered" the trip, namely, Arthur W. Turner, educational adviser, International Harvester Co., who had charge of the trip to Madison from Chicago, and F. W. Duffee, head of agricultural engineering department at Wisconsin, who arranged the tour of the University campus, assisted by S. A. Witzel, H. D. Bruhn, and other staff members.

The accompanying picture taken during the tour includes (standing, left to right) V. E. Kivlin, assistant dean of agriculture and professor of agricultural education, University of Wisconsin; H. J. Washburn, Harvester assistant manager at Madison; Wm. Setzler, Harvester assistant manager at Mexico City; Dr. C. A. Dykstra, president, University of Wisconsin; W. R. Ploetz, Harvester branch manager at Madison; Prof. Duffee; (seated, left to right) Miguel Cardenas, Mexican attorney and president of Equipos Mecanicos S. A. of Mexico; Chris L. Christensen, dean of agriculture, University of Wisconsin; Senor Gomez, and D. J. Conway, International Harvester Export Co.



Student Branch News

STUDENT BRANCH COUNCIL

MEMBERS of student branches will be interested to learn that Edwin T. Mims, president of the National Council of A.S.A.E. Student Branches for the year 1941-42, has been elected to membership in "Who's Who Among Students of American Universities and Colleges." Mr. Mims is a senior student in agricultural engineering at the University of Georgia, and in addition to the honor just referred to, he is a member of the local honorary science Society, Xi Phi Xi; of the national honorary physics Society, Sigma Pi Sigma, and of the national Alpha Zeta, honorary agricultural society, of which he is also scribe. He is also president of the Ag Hill Council, an organization of students representing the schools and colleges located on Ag Hill of the University of Georgia campus, and is also associate editor of "Red and Black," university student publication. Mr. Mims conceived and was editor of the first edition of the "Student Ag Engineer," sponsored during the past school year by various student branches of A.S.A.E.

For the further information of A.S.A.E. student branches, the following are the other officers of the national student branch council for the current year: First vice-president, Dale Woolsoncroft (Iowa State College); second vice-president, Gus Boesch, Jr. (A. & M. College of Texas); secretary, Julius E. Purvine (Oregon State College).

GEORGIA

By T. Lumsden, Scribe

THE second regular biweekly meeting of the Georgia Student Branch of the American Society of Agricultural Engineers met October 27, 1941. The interest for the evening was a quiz program, with Harold Fletcher and Irby Exley in charge. Candy, cigars, and apples were given freely as prizes for correct answers. Before the meeting adjourned, President O. W. Ginn thanked the faculty for helping the club put on one of the most successful dances of its kind ever held on the University of Georgia campus.

The dance was held on October 24 in the Physical Education Building. A canopy of red, white, and blue crepe paper swept gracefully from the four sides up to a high rectangle in the center. A three-foot cube with the A.S.A.E. emblem in blue print on each side was lighted from the inside and suspended from the highest point in the center of the canopy. Billy Strauss, Decatur, directed the decorating activities.

The boys of the Georgia Student Branch set a new record on the agricultural campus in advertising dances. A mammoth blueprint bearing the A.S.A.E. emblem and the silhouette of a dancing couple was mounted on a frame and attached to a small wagon chassis. After being decorated with red, white, and blue strips, the wagon was pulled around the campus at intervals for several days prior to the dance with a John Deere tractor. This advertising stunt attracted considerable attention and broke up several classes. As a result, a large crowd attended the dance. By charging couples 25 cents and stags 35 cents, approximately enough money was made to cover the total cost, which was $97.00.

Sixteen new members were initiated into the club at the last regular meeting held November 10. David Firor, Athens, was in charge of the initiation. *(Continued on page 450)*

AGAIN IN 1942!

National 4-H Club Rural Electrification Contest

Six valuable college scholarships for national winners; a free trip to the National 4-H Club Congress for each state winner; handsome pins for all county winners—these are the valuable awards offered to Club members excelling in the study of electricity during 1942.

For the seventh consecutive year, this opportunity is offered to 4-H Club members who enroll in the National Rural Electrification Contest, sponsored by Westinghouse. But in 1942, this Contest takes on added importance and significance.

Never before in our country's history has electricity been so important on the farm and in the home. Due to requirements of National Defense, there is urgent need for increased production of vital foods. This calls for extra help—but less man power is available. Electrical help can fill this gap to a large extent, by doing work formerly done by hand and stepping up efficiency in many other ways.

Along with the need for increased food production is the need for better health. A keystone in this program is wider knowledge of how to process and prepare foods to retain vital minerals and vitamins. Proper use of electricity can play a major part in protecting food quality.

Such information, gained from enrolling in the National Rural Electrification Contest, can be put to immediate, practical use. 4-H Club projects are many and varied, but in every one of them—directly or indirectly—electricity has an important place.

Studying these applications of electricity holds many benefits for Club members, their Clubs and their communities. In addition, the Contest provides valuable awards for work well done.

Requirements for completing the Contest are not difficult. The important thing is to plan entries now and secure helpful information, including the 1942 Guide Book; Report File for Contestants; and Folder of Suggestions for Leaders. The Contest is a year-round activity; send the coupon TODAY for full information. You can help—and be helped by—this important activity.

Westinghouse

ELECTRICAL PARTNER OF AGRICULTURE

clip and mail

Westinghouse Rural Electrification,
306 4th Ave., Pittsburgh, Pa.

Please send me full information about the 1942 National 4-H Club Rural Electrification Contest.

☐ I am interested in knowing how this Contest can fit in with my own Rural Electrification work.

Print Name_____

Street or R.F.D._____

Town_____ State_____

Remarks_____

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Copies of publications reviewed may be procured only from the publishers at the addresses indicated.

FARM ELECTRIFICATION IN IDAHO, *H. Beresford*. Idaho Agrl. Exp. Sta. (Moscow) Bul. 237 (1940), pp. 32, pl. 1, figs. 52. This is an abundantly illustrated popular summary of the progress of rural electrification in Idaho, with a brief statement concerning current research projects. It is noted that 64.2 per cent of all occupied Idaho farms have electric service, as compared with the national average of 27.8 per cent, and that 87.44 per cent of Idaho farms with dwellings valued at more than $500 now have electricity. The kilowatt-hour use by the farms of Idaho is twice the national average for domestic service.

IRRIGATION, DRAINAGE, AND GROUND-WATER INVESTIGATIONS AT THE UTAH STATION. Utah Agrl. Exp. Sta. (Logan) Bul. 294 (1940), pp. 9, 76-79, figs. 3. This report notes irrigation surveys covering more than 207,000 acres, water-application efficiencies in irrigation and their relation to irrigation methods, snow surveys, and the application of hydromechanics to the design of structures for controlling ground water, the last-named study having shown that pumping wells are the most practical solution for the problem of the drainage of lands waterlogged from underlying artesian basins.

VOLUME BY MOMENT, *J. C. Sammi*. N. Y. State Col. Forestry, Syracuse Univ. (Syracuse), Bul. 13 (1940), no. 3-b, pp. 18. The author has based his method on the theorem, $V = 2\pi r A$, in which V is the volume, r is the moment arm (distance from axis of revolution to center of gravity), and A is the area of the body, and on the further fact that, just as it is possible to determine the area of an irregular figure by means of the planimeter, the force moment of such a figure can be determined by using a second-order mechanical integrator. The force moment, M, being equal to rA, the formula may be written $V = 2\pi M$. The method of moments was shown to be superior to the use of either the Smalian or Huber formula. "It is no better than the 558a method may be made (when the forms are printed on a better grade of paper)." The method is applicable to the development of form factors from percentile measurement and is a means of greatly reducing the work in obtaining form factors from percentile measurements, but "still greater usefulness can be obtained if field measurements are so taken as to permit the delineation of the curve of that section of the tree profile below the DBH point. It is then possible to obtain either normal or merchantable form factors (form factors based on total height above stump or on merchantable height.)"

It was found that the plotting of the tree profile on rectangular cross-section paper presents a relatively undistorted picture of the stem of the tree. The instrument used costs about $300, however. The method of obtaining the equation of the curve of the log or tree profile is both quick and simple. The type equation is more flexible than any of the others considered. The determination of the value of the exponent, n, is delicate by the area method, but not so much so by the volume method. The equation is most effectively used when developed on the basis of averaged measurements for a large number of trees of a given diameter and height class or when developed on the basis of averaged percentile measurements. The results attained by the new method outlined are more accurate than those obtainable by a purely mathematical treatment because the integrator follows the change of slope in the curve of the tree profile.

FROST ACTION IN HIGHWAY BASES AND SUBGRADES, *H. F. Winn and P. C. Rutledge*. Purdue Engin. Exp. Sta. (Lafayette, Ind.) Res. Ser. 73 (1940), pp. 104, figs. 41. The soils tested include a natural sandy clay and mixtures of this clay with concrete sand and with pit-run gravel. Test results showed that the clay is susceptible to severe frost action. Admixtures of sodium chloride, calcium chloride, calcium oxide, portland cement, tar, emulsified asphalt, cut-back asphalt, road oil, and a resinous by-product of turpentine distillation were used. All specimens were frozen slowly from the top down, and similar conditions of temperature variation prevailed during all tests. Observations of the relative total amount and rate of ice segregation and frost heaving and of the time, temperature, and location of initial ice segregation for each specimen were made and were compared with the cumulative degree-hours of freezing temperatures in the air above the specimens. All changes in water content were measured, and the appearance of the frozen specimens was recorded by sketches and photographs.

Tests of the permeabilities of treated and untreated soils and mixtures in a device known as a constant-head permeameter, in which pressure heads up to 26 ft of water are obtained by means of air pressure were also carried out. The addition of small percentages of bituminous admixtures to a sandy clay greatly increased its permeability. Larger percentages of admixture (from 10 to 12 per cent by weight) reduced the permeability approximately to that of untreated soil. To a lesser degree portland cement admixtures gave the same results.

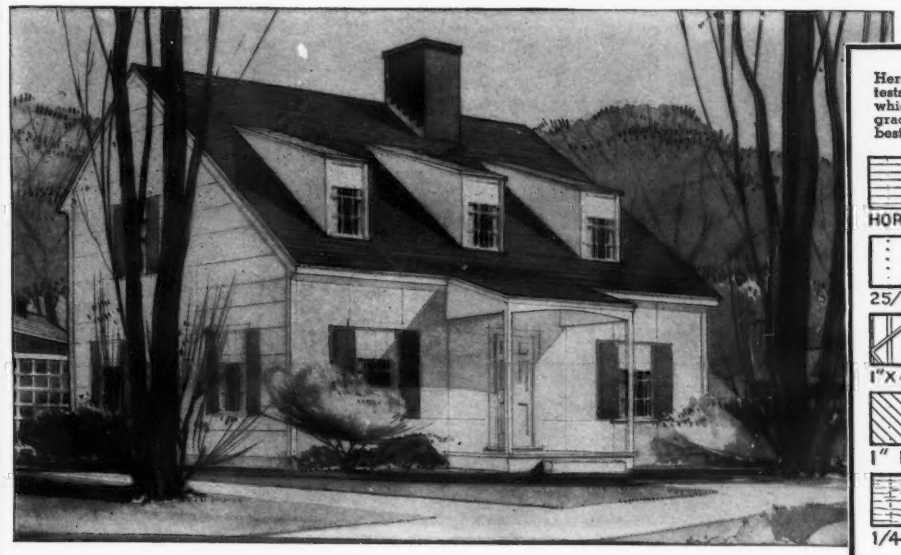
Field observations of soil temperatures and of moisture-content variations in treated and stabilized soils and soil mixtures under actual climatic conditions occurring in central Indiana, automatically recorded during the period January 6 to April 1, 1939, indicated that fluctuations in air temperature over periods of a few days did not cause corresponding fluctuations in the temperature of the subgrade soil, but that subgrade temperatures are a function of cumulative air temperatures rather than periodic air-temperature fluctuations.

The percentage of heave indicates the general extent to which frost action may be expected to occur in various mixtures but cannot be taken as a basis for rigid comparison of mixtures or admixtures, the exact extent of the frost heave being entirely dependent upon the conditions of initial moisture content, density, thickness of layer, and temperature, a variation in any one of which might result in a decided change in the relative amounts of damage. In general, the natural fine-grained sandy clay started to heave sooner, heaved at a greater rate, reached a greater total heave, reachd capillary saturation more readily, and had less resistance to moisture-content fluctuation than did treated and stabilized sandy clay exposed to the same conditions. The data indicate that the frost line penetrates a graded-soil mixture at a greater rate than it does a natural fine-grained sandy clay. Rapid freezing results in less ice segregation and less total heave for the same depth of frost penetration. The available data indicate that there is a critical density for sandy clay at which frost action occurs most readily when material is saturated. Below the critical density, frost action is directly proportional to density; above the critical density, frost action is inversely proportional to density. Increasing the density above the critical density increases the period of inactivity before heaving starts and decreases the rate of heaving and total heave in a manner similar to that of the addition of admixtures.

All the admixtures tested were much more effective in reducing frost action when used with well-graded soil mixtures than when used with natural sandy clay. Lime did not increase resistance to frost action enough to warrant its use. Sodium and calcium chlorides reduced the frost damage primarily by lowering the freezing point. Of either chemical, 2 per cent actually retained in the soil prevented freezing at from −10 to −15 F. Resistance to frost action in soil-cement mixtures and in bituminous mixtures was inversely proportional to the degree of water saturation at the beginning of freezing. Portland cement, tar, cut-back asphalt, road soil, emulsified asphalt, and vinsol, a byproduct of turpentine distillation, added stability to a sandy clay by inhibiting capillary motion of the water to various degrees closely related to the percentage of admixture and moisture content of the mixture at the time it is exposed to the water.

AGRICULTURAL ENGINEERING AT THE TEXAS STATION. (Partly coop. U.S.D.A.) Texas Agrl. Exp. Sta. (College Station) Rpt. 1939, pp. 122-125, 151-154, 177-180, 198-200. Mechanical harvesting of cotton is briefly taken up by H. P. Smith, D. T. Killough, D. L. Jones, and M. H. Byrom; efficiency in distribution and placement of cottonseed and fertilizer, treatment of cottonseed for planting purposes, and atmospheric exposure of wire and fencing, all by Smith and Byrom; and garlic drying, by Smith and C. E. Altstatt. Soil and water conservation work at the Tyler, Temple, and Spur Substations is also reported by J. B. Pope, O. C. Word, and J. C. Archer; H. O. Hill; and R. E. Dickson, B. C. Langley, and C. E. Fisher, respectively. *(Continued on page 450)*

Homes go up faster, provide more comfort when they're dri-bilt WITH PLYWOOD



Here are the results of Government tests at U. S Forest Products Laboratory which show that Plyscord, the utility grade of Douglas Fir Plywood, is the best structural sheathing.

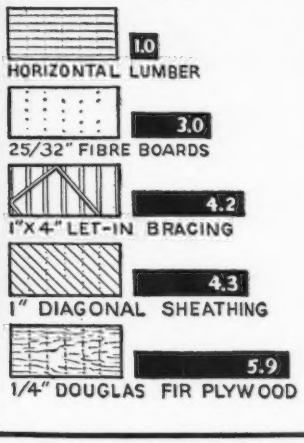


Illustration at left shows National Homes Foundation farm house No. F3N, built of Douglas Fir Plywood. Working drawings and material list for this home may be purchased through your lumber dealer.

Send for National Homes Foundation's 8 village and farm house plans adapted to Dri-Bilt with Plywood construction

Plywall for Interiors

When homes are built of Douglas Fir Plywood, they are ready for occupancy as much as 6 weeks sooner than traditionally built houses because there is no "waiting to dry out" period. Interior walls of Plywall are ready to take any finish the instant they're up. They are crack-proof and kick-proof, too. Because the big 4'x8' plywood panels cover 32 sq. ft. in one piece, there is a minimum of handling, cutting, fitting and nailing.

Douglas Fir Plywood has many structural advantages: 5/16" Plyscord sheathing makes walls 5.9 times as rigid as horizontal board sheathing. A Plyscord sub-floor forms a diaphragm resistant to earthquakes and high winds. Plywood walls are wind-tight and dust-proof. They are 5 times more sound absorbent than ordinary walls. They provide excellent insulation, too.

Exterior-type Plywood

Plyscord for 1-Use Forms

Plyform for Multiple-Use Forms

The plan booklets showing how the National Homes Foundation's 8 village and farm houses can be built of Douglas Fir Plywood will give you a clear picture of Dri-Bilt with Plywood construction. Write for them . . . and for the Dri-Bilt with Plywood Manual. There is no charge. Remember, both the National Homes Foundation plans and Dri-Bilt with Plywood construction are accepted by F.H.A.

FREE PLAN BOOKLETS

- Northern Village House V1N (1 Story, 2 B.R.)
- Southern Village House V4S (2 Stories, 3 B.R.)
- Northern Farm House F3N (2 Stories, 3 B.R.)
- Southern Farm House F1S (1 Story, 2 B.R.)
- Northern Farm House F4N (2 Stories, 3 B.R.)
- Southern Farm House F2S (1 Story, 3 B.R.)
- Southern Village House V2S (2 Stories, 3 B.R.)
- Dri-Bilt Manual (Traditional)
- Southern Village House V3S (2 Stories, 2 B.R.)
- DFP Dri-Bilt Method (Shop Assembly)

Douglas Fir Plywood Association
Tacoma Building, Tacoma, Washington

DOUGLAS FIR PLYWOOD
Real Lumber
MADE LARGER, LIGHTER
SPLIT-PROOF
STRONGER

GENUINE DOUGLAS FIR PLYFORM Concrete Form Panel D.F.P.A. INSPECTED

GENUINE PLYWALL Douglas Fir Plywood WALLBOARD D.F.P.A. INSPECTED

SPECIFY DOUGLAS FIR PLYWOOD BY THESE "GRADE TRADE-MARKS"

PLYPANEL D.F.P.A.

EXT.-D.F.P.A.

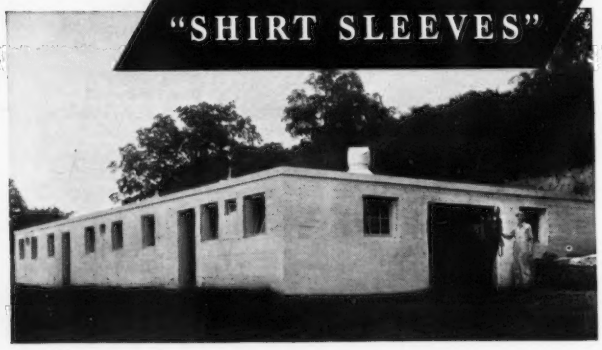
GENUINE PLYSCORD SHEATHING D.F.P.A.

"SHOW PLACE" or

This fine-looking, all-concrete structure is on Charmany Farm, Madison, Wis.

Simple, neat, good-looking. Concrete barn on Women's State Prison Farm, Taychedah, Wis.

"SHIRT SLEEVES"



Farm structures need these advantages of

CONCRETE

Some farm structures are built to advertise quality farm products—others strictly for shelter and utility. Concrete offers these basic advantages for both:

ECONOMY—Concrete assures long life with little expense for upkeep. Where low cost is a prime consideration, home labor and home materials are frequently available.

GOOD LOOKS—With concrete, pleasing appearance can be obtained at very low cost. And concrete's beauty endures with minimum upkeep.

FIRESAFETY—Everyone knows and accepts the desirability of building for firesafety with concrete. Make it your job to encourage more and more firesafe construction on the farm.

GOOD INSULATION—Walls of low thermal conductivity can be designed *economically* either with reinforced concrete or concrete masonry. Wide range of insulative value, depending on wall design, thickness, type of aggregate and method of insulation.

Write for helpful literature, or ask for one of our agricultural engineers to assist you on any design questions involving the use of concrete.

PORTLAND CEMENT ASSOCIATION

Dept. A12-1, 33 W. Grand Ave., Chicago, Ill.

A national organization to improve and extend the uses of concrete . . . through scientific research and engineering field work

Agricultural Engineering Digest

(Continued from page 448)

THE OPERATION, CARE, AND REPAIR OF FARM MACHINERY. John Deere (Moline, Ill.), 9th ed., pp. [3]+225, figs. 220. It is the purpose of this book to assist instructors in farm mechanics in giving a thorough and practical course in the operation, care and repair of the more important farm machines. It is designed especially for those studying farm mechanics in high schools, colleges, and short courses with the expectation of applying the knowledge gained to actual farming or to teaching. Part 1, on the preparation of the seedbed, contains chapters on plows, including plow bottoms, walking plows, riding plows, tractor plows, disk plows, and wheatland implements; disk harrows; and harrows, pulverizers, and field cultivators. Part 2, planting, deals with grain drills, corn planters, cotton and corn planters, listers, and potato planters. Part 3, cultivating, takes up rotary hoes, shovel cultivators, disk cultivators, and listed crop cultivators. Part 4 includes, under the head of harvesting—grain binders, combine harvesters, corn binders, ensilage harvesters, corn pickers, potato diggers, mowers, and hay rakes and loaders. Part 5 discusses tractors and gasoline engines as sources of power on the farm. Part 6, headed soil fertility, contains chapters on manure spreaders and lime and fertilizer sowers. An appendix of useful information comprises a chart for calculating the acre-hour capacity of machines of any width of cut at from 1 to 5 mph, and various tabulated data for computing machine requirements, areas, weights, and capacities of several varieties of storage spaces.

This edition is more complete in its coverage of detail than the previous editions. *(Continued on page 452)*

STUDENT BRANCH NEWS

(Continued from page 446)

OHIO

By Harold L. Geiger

ONLY twenty-nine old members returned to the Ohio Student Branch of A.S.A.E. when school started; the armed services had called many of them. That these fellow students might not be forgotten, a service directory was promptly prepared to foster correspondence. The members get many interesting letters.

In spite of the ten per cent decrease in enrollment of freshmen in the college of agriculture at Ohio State University, 26 freshmen declared their major to be agricultural engineering. Most of them attended the openhouse party, October 16. Professor G. W. McCuen introduced the entire faculty and reviewed the fields of agricultural engineering. In addition to skits and games, the freshmen were impressed with hot dogs, cider, doughnuts, and apples.

A very successful square dance gave entertainment on November 7, for the small sum of twenty-five cents per couple. Two machinery laboratories were cleaned and decorated to make room for the square dance orchestra, dancing, card playing, ping pong, dart games, and a DuPont motion picture on the side. An electric fence kept couples from straying far.

A banquet was held on December 4 in honor of one graduating senior, one initiate into Tau Beta Pi (engineering honorary society), and four initiates into Gamma Sigma Delta (honor society of agriculture).

All is not play with the members of the Ohio Branch. There has been a speaker at each of the biweekly meetings. Reports were given of the A.S.A.E. annual meeting in June and of the 1941 industry seminar.

A drive is in operation to have each member wear an official A.S.A.E. pin. A photography dark room is available to all members. Work has begun in planning the 1942 yearbook. Preparations are made for operating the farmer's week lunch-counter. Society teams are active in intramural athletics.

This year's officers are: *President,* Charles S. Morrison; *Vice-President,* Richard S. Keep; *Secretary-Treasurer,* Ralph E. Patterson; *Sergeant-at-Arms,* Bill M. McCormac; *Engineer's Council,* Harold L. Geiger, Bernard W. Hatten; *All-Ag Council,* Richard T. Brown; *Faculty Advisor,* W. A. Junnila.

MISSOURI

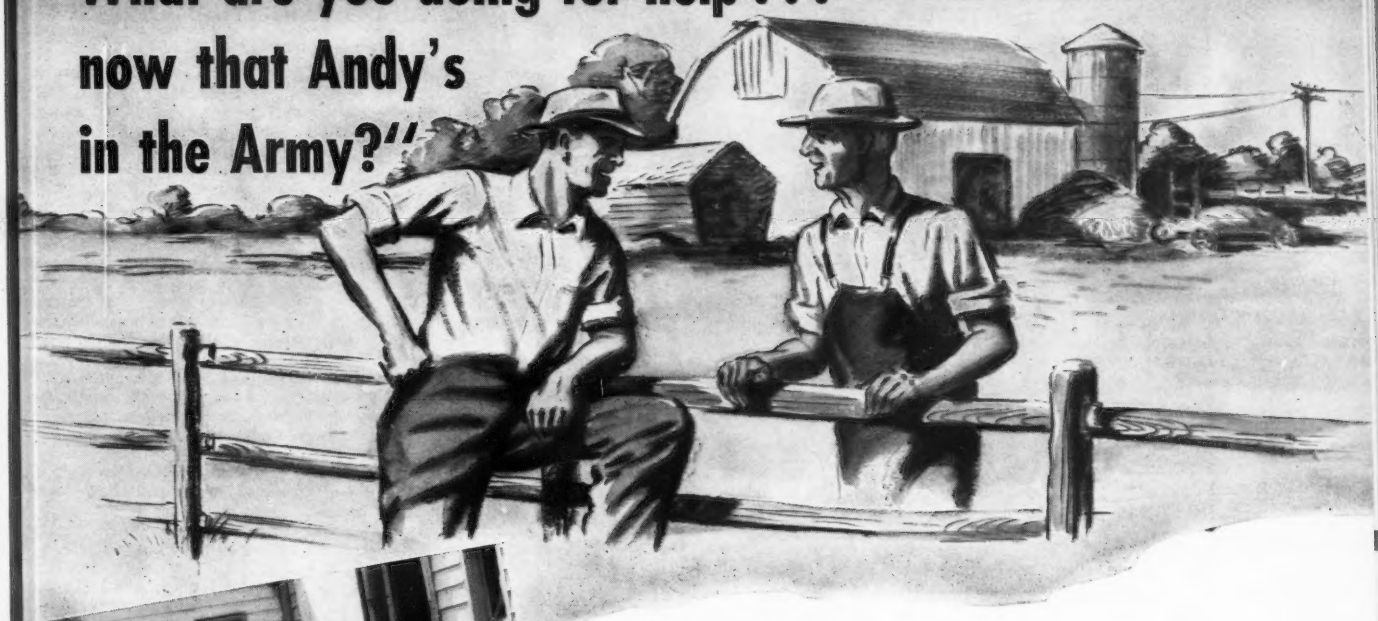
THE meetings of the Missouri Student Branch of A.S.A.E. are held semi-monthly, five of which have been held to date. The programs consist of talks by student members and educational motion pictures. The membership at the present time is seventeen.

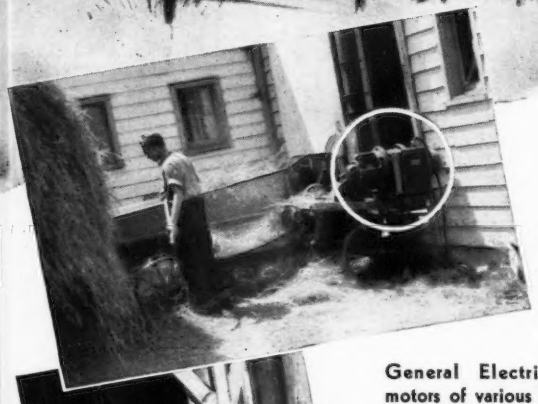
A get-acquainted picnic was held on October 6. There was a good attendance, and everyone enjoyed a good time.

Other planned activities are as follows. The publication of our student branch annual "Ag Engineer", an exhibit at St. Pat's Week, and an exhibit at the Farmer's Fair in the spring. Plans are also being made to compete for the F.E.I. cup award.

A dance is planned for December 13. A banquet for students and faculty members is to be held late in the spring.

"What are you doing for help . . . now that Andy's in the Army?"





General Electric builds motors of various types and sizes for many applications. Convenient, portable apparatus (above) can simplify numerous operations such as grain elevating, hay cutting and blowing, threshing, etc. (Left) A sturdy, reliable G-E motor drives this feed grinder.

"I'm using ELECTRIC EQUIPMENT!"

"WHEN Andy left I soon found I couldn't do all the work alone. But I also 'discovered' a number of places where electric equipment could handle jobs for me. So I rewired the barn, installed the necessary equipment, and now I'm doing as much alone as the two of us did together. And flipping a switch is easier than waking Andy."

Yes, with proper electric equipment, much farm work becomes merely a matter of plugging in, not lugging in—a mighty important feature in these days of national emergency *when manpower is scarce*. When farmers in your locality come to you for help in this matter of replacing missing manpower, why not suggest a thorough investigation of farm electrification. We have two new bulletins to help you answer their questions; send for your copies today. General Electric Co., Schenectady, N. Y.

General Electric, Sect. 980-3
Schenectady, N. Y.

Please send me the following:

☐ "Electric Helpers for the Farm Family"—44 pages of helpful information on how to make electricity most useful on the farm.

☐ "General Electric on the Farm"—A complete catalog of G-E equipment for farm use.

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Loosening soil 18 to 24-inches deep with a TD-9 and subsoiler.

DIGGING IN with the TD-9!

Digging in and getting a job done fast and efficiently is characteristic of the International Harvester family of four Diesel TracTracTors. Rugged power as well as speed, economy, and maneuverability make these crawlers ideally suited for the increasingly important work assigned to them daily in America's front lines of Defense, Agriculture, and Industry.

INTERNATIONAL HARVESTER COMPANY
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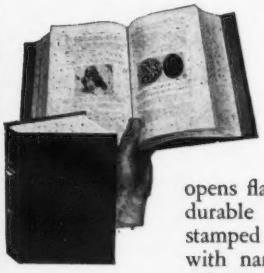

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Agricultural Engineering Digest

(Continued from page 450)

METHOD FOR DETERMINING THE MOISTURE CONDITION IN HARDENED CONCRETE, *G. R. Gause and J. Tucker, Jr.* Jour. Res. Natl. Bur. Standards, Washington, [U. S.], 25 (1940), no. 4, pp. 403-416, figs. 13. An electric hygrometer developed at the National Bureau of Standards for radio-sonde use is described, together with a method for using this hygrometer to measure the relative humidity inside cavities within concrete.

The rh (relative humidity) in cavities at various locations in the material inside 12-in concrete cubes stored at 50 per cent rh for 300 days was found to range from 50 per cent near the surface to 66 per cent near the center of the cube. For cubes stored at 20 per cent rh the corresponding range was from 20 to 60 per cent. The rh inside coated specimens was higher than in the uncoated specimens, but the results indicated that none of the coatings were impermeable to water. The rh inside hermetically sealed concrete specimens was found to decrease as the temperature decreased and to return to its original value when the temperature was increased to its original value. The rh over neat-cement pastes of approximately normal consistency and cured in hermetically sealed containers was measured. The rh decreased to 94 per cent at 7 days and to 88 per cent at 28 days, over a moderate heat-of-hardening cement, and decreased to 88 per cent at 3 days, to 82 per cent at 7 days, and to 79 per cent at 28 days, over a high-early-strength cement.

The electric hygrometer appears to be well suited to the measurement of rh inside concrete and over cement pastes.

OAT CHOP SIFTER. Dept. of Agr., (Edmonton, Alta.), 1941, p. 1, pl. 1. The chop sifter or hull separator here described consists essentially of a sifting drum of wire screening, 3 ft in length by 16 in in diameter, mounted on six longitudinal slats 0.5 by 0.75 in which are attached through wooden hubs to a 1-in wooden shaft by three sets of 0.75-in round spokes, together with a tin-plate feeding worm or auger, 4 in in diameter, placed about the upper end of the shaft (sloped 1.5 in to 1 ft) and projecting out of the drum and revolving in a tin-plate cylinder attached to a tin-plate hopper. This device is mounted in a simple wooden frame and is operated by a crank attached to the upper end of the shaft. Working drawings accompany this circular.

It is pointed out that although the hulls and other coarse parts of the chop are suitable for feeding to cattle and horses, pigs up to 3 or 3.5 months of age should have no oat chop which has not been sifted.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

AGRICULTURAL ENGINEER wanted for farm structures research work in the agricultural experiment station of a southeastern college. Only a man with some research experience and not subject to immediate military service will be considered. Work will be primarily concerned with storage buildings. Good fundamental training with good scholastic records necessary. Salary up to $2,700 according to qualifications. PO-134

POSITIONS WANTED

AGRICULTURAL ENGINEER, also farm and supply manager, has had 20 years' experience in agricultural pursuits as manager of large farming enterprise and agricultural supply house, and as chief agricultural engineer of large irrigation development in the West. Has had technical training and practical experience in all phases of engineering and agricultural production, development, and marketing. Best of references. Forty-four years of age. Married. PW-341

AGRICULTURAL ENGINEER with 15 years' experience in the farm equipment industry; knows both farmer and tractor and implement industry in all sections of world; especially Canada and U.S.; advertising, public relations, editorial, camera, radio; can direct a complete service for dealers and factory; knows governmental and agricultural college officials; Farm Bureau; boys' and girls' clubs, livestock and special crop associations. Will locate anywhere the right firm or industry may wish. Have production records that speak. Personal portfolio mailed on request. PW-343

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AGRICULTURAL ENGINEERING

DECEMBER 1941

Seed Drier and Conditioner Uses Infrared Electric Lamps *Nicholas and Musser*

Some Case Studies in Investigations of Low-Cost Housing *Deane G. Carter*

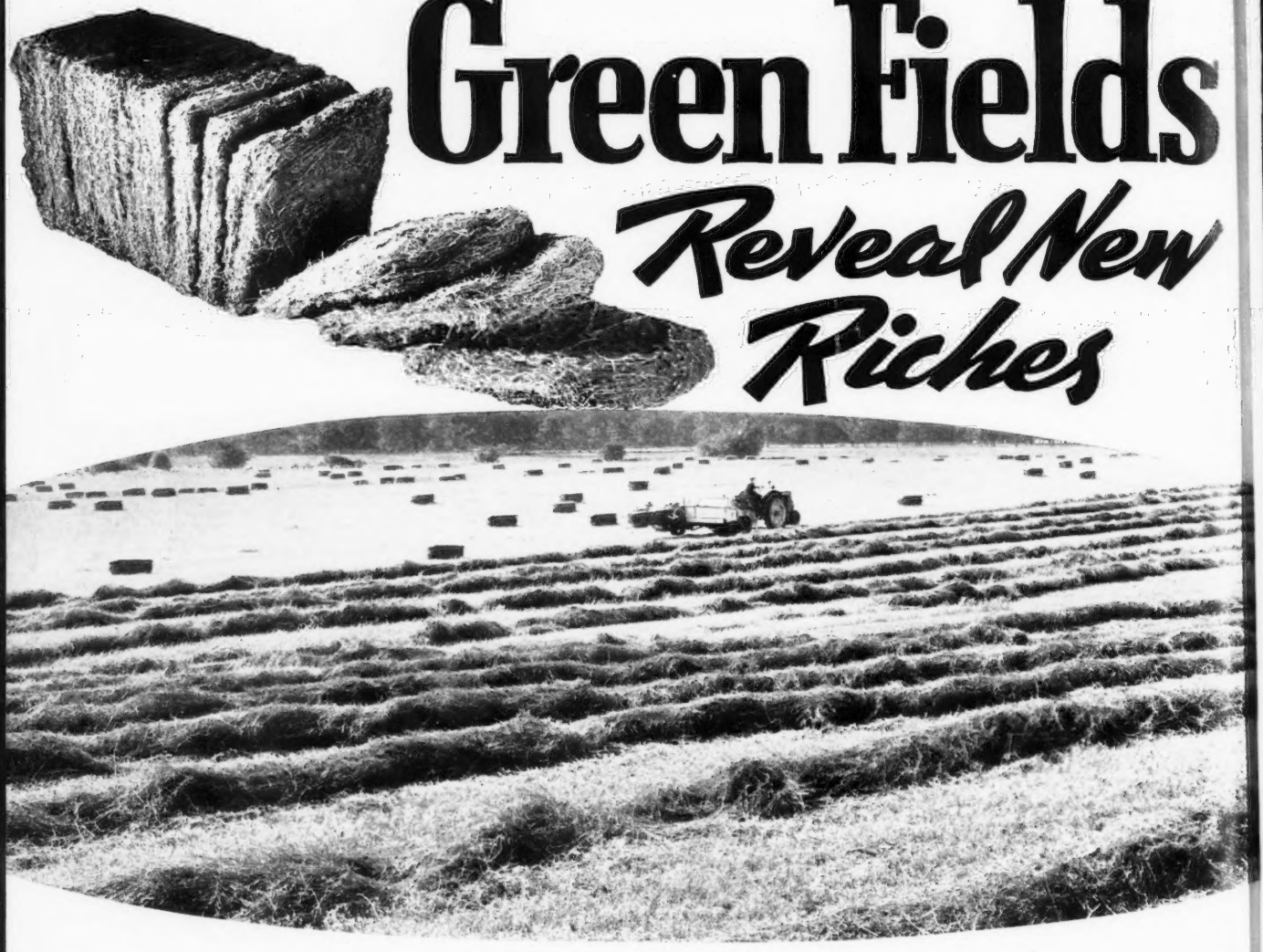
Design of Plot Experiments for Measuring Run-off and Erosion *Dr. A. E. Brandt*

How Much Rental Can a Cow Afford to Pay for Housing? *M. Glen Kirkpatrick*

Some of the Economic Possibilities of Farm Mechanization *Dr. R. B. Corbett*

THE JOURNAL OF THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Green Fields Reveal New Riches



In 1842 a young man, Jerome I. Case, began to furnish American agriculture with grain-saving machines. During his life he became the world's greatest builder of threshers and steam traction engines. In 1942 the company he founded will observe its centennial with such historical ceremonial and educational program as may be expedient in the prevailing state of affairs. You are invited to share in these activities.

1842 CASE Centennial Jubilee 1942

CASE

More milk in the pail, more meat on the hoof mean new morale for a hungry world, new money for the farmers you serve. More grasses and legumes on America's acres mean new safety for soils, new security for posterity. New discoveries in the arts of agronomy and animal husbandry disclose new virtues in green leaves, demand new vigilance from meadow to manger.

All these aims are achieved in amazing measure by Sliced Hay — air-conditioned hay harvested by the Case System and baled from the windrow with the new Case "NCM" pick-up baler shown above. From stalk to stomach it delivers more leaves, more protein, more minerals, more total nutrients per acre than ever before was practicable. It contains plenty of carotene for normal farm rations and rotations. From field to feedlot, including expense of suitable storage, it costs far less than equivalent amounts of forage feed put up in any other fashion.

The Case Sliced-Hay Pick-Up Baler is deliberately designed for individual use on family-size farms. Because it handles a seven-foot windrow at the same speed as tractor-powered mower and rake, it keeps successive steps synchronized, holds haying hazards to the minimum, captures the maximum of hay value. Powered by its own engine and weighing no more than a medium motor car, it pulls with a light tractor or truck. Building bales to uniform length with automatically spaced dividers it has no blocks to handle, needs only one operator and a boy to help with the ties. And when the bales are opened, Sliced Hay is easy to feed as serving sliced bread.

As engineers and as counsellors to agriculture you are invited to see for yourself this machine and the advances it makes in forage farming and feeding. You are always welcome at our branch houses and factory show rooms.

J. I. CASE CO., Racine, Wis.

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A LUMP OF ZINC ORE—unattractive, insignificant, commonplace!

But with the light of science shining upon it, let your imagination visualize the reflections which emanate from it!

In defense: on land, on sea, in the air, Zinc is an essential in the construction of ammunition, armament, battleships, airplanes. In industry, Zinc enters vitally into the construction of engines, tools and machinery. In agriculture, Zinc in one form or another protects homes, crops, orchards, animals. In ways almost infinite in variety, Zinc is used to effect economy, increase efficiency, improve safety, augment profits.

It pays to KNOW about Zinc. It is essential in defense. In the period of America's greatest industrial development, Zinc has rendered indispensable service; it is reasonable to expect that it will be utilized even more extensively in the greater developments yet to come.

An interesting mine-to-market story of Zinc is told in "The Zinc Industry," a booklet that will be sent free to any teacher or student who asks for it and gives the name of the school with which he is connected.

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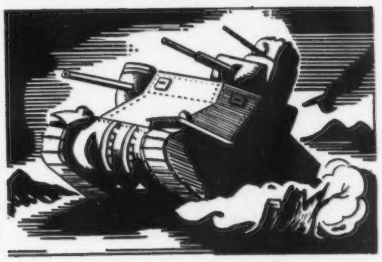
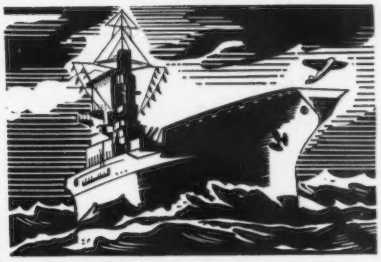
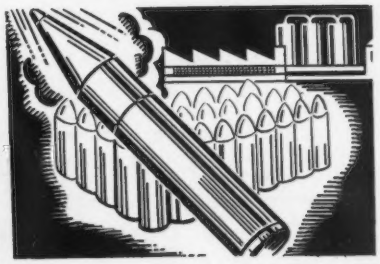
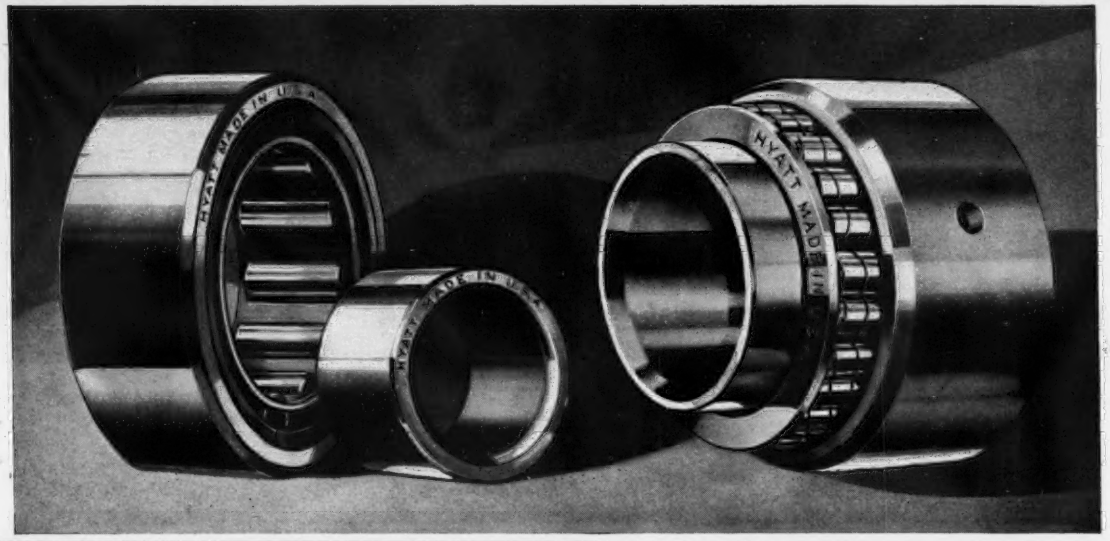






MAKE LIGHT OF HEAVY LOADS



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Where the loads are heavy and the going is tough you can depend on Hyatt Roller Bearings for any application.

Precision-built... incredibly accurate... great in capacity... Hyatts are helping to lighten the loads of all mechanized defense equipment while serving in their regular role of keeping tractors and farm machinery free from bearing wear and care.

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According to recent statistics, 46% of all plows now being manufactured are going on pneumatic tires. Many of these new rubber-tired plow wheels naturally are mounted on Timken Tapered Roller Bearings—the same as tractor and combine wheels—thus permitting sustained high speed operation and giving the wheels complete mastery over radial, thrust and combined loads. Lubrication also is greatly simplified.

The advantages of air-tired plow wheels of course are obvious to every agricultural engineer and plow manufacturer. Farmers are rapidly discovering them. These advantages include: faster plowing; better operation in soft ground; elimination of wheel breakage; easy transportation of plows by road.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

Manufacturers of Timken Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; Timken Alloy Steels and Carbon and Alloy Seamless Tubing; and Timken Rock Bits.